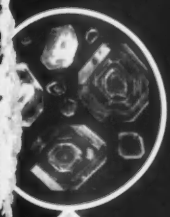
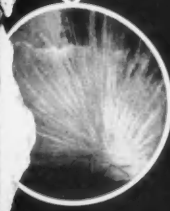
CHEMISTRY

DUKE UNIVERSITY LIBRARY

CHEMISTRY DEPARTMENT LIBRARY FEB 3 1961



JANUARY
1961



THE CHEM STUDY

DURHAM, N. C.

	Page
Chromatography Laboratory: Apparatus Article	17
On the Back Cover	19
Proudly Presented	20
Mineral Discoveries in China	25
Chemical Companies: Union Carbide	26
New Chemical Patents	33
Chemistry Quiz	34
For the Home Lab: Cosmetics	35
AICE Meeting	38
The Inversion of Sucrose: STS Project Report	40
Ten Top Science Advances	44
Scientists in Campaign	45
Book Condensations	47
Chemistry Comments	48

Editorial:
Chemistry and Geology
Inside Front Cover

50¢

Thirty-fourth Year

A SCIENCE SERVICE PUBLICATION

XUM

Chemistry and Geology

➤ GEOLOGY is defined as the science which treats of the history of the earth and its life. It gathers its information from the atmosphere, the hydrosphere, the earth's surface and the earth's interior.

The techniques of chemistry have been widely applied to the problems of geology. A new science has developed called geochemistry. Geochemistry has been defined as the science that seeks to determine the composition of the earth and to discover the laws which control the distribution of the individual elements.

The ordinary wet methods of chemical analysis have been long a standard technique for the examination of rocks and ores. Spectrographic analysis has been widely accepted as an important tool for geology. Newer techniques have included fluorescent X-ray spectrography, mass spectrometry, radiochemical methods, polarography and chromatography.

Using these techniques the geologist has learned more about how rocks and minerals have been deposited in the earth. He has been able to learn more about the petroleum and natural gas deposits of the earth. The movement of water underneath the surface of the earth has been followed more closely.

CHEMISTRY

Vol. 34, No. 5 Formerly Chemistry Leaflet January, 1961

Including The Science Leaflet

Published monthly, September through April, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 326 W. Beaver Ave., State College, Pa. Second class postage paid at State College, Pa., and at additional mailing offices. Address subscriptions and editorial communications to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

$4 a Year; Two-Year Subscriptions $7; Your Own and a Gift Subscription $7 a Year. 50¢ a Copy. Ten or more subscriptions to the same address: $2.90 a Year each. No charge for Foreign or Canadian Postage.

Editor: WATSON DAVIS **Assistant Editor:** BURRELL WOOD

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Editor in Memoriam: HELEN MILES DAVIS (1944-1957)

Copyright © 1960 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS of Science (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the Scripps Estate and the Journalistic Profession.

THE CHEM STUDY

This article reports on the progress being made in the Chemical Education Material Study or the CHEM Study. This study is concerned with the high school chemistry curriculum. This investigation is supported by the National Science Foundation as is the Chemical Bond Approach Project at Earlham College. The CBAC work has been reported in the February 1960 and the September 1960 issues of CHEMISTRY.

➤ THIS IS A REPORT describing progress as it is being made in a high school chemistry curriculum study, — the Chemical Education Material Study or, briefly, the CHEM Study. Perhaps it would be appropriate to give some of the background which led to this project and a brief review of its history, as well as a discussion of our objectives and plans for the future.

The project is an outgrowth of a study committee set up in 1959 by the American Chemical Society under the chairmanship of Professor A. B. Garrett of Ohio State University to examine the purposes and content of high school chemistry courses with the view to the production of a drastically improved course. Following the receipt of the recommendations of this committee and also as the result of the apparent need for a broad study in this area, a proposal from the University of California at Berkeley to undertake such a study was submitted to the National Science Foundation. In recognition of the need and importance of such an undertaking the proposal was supported, and it was immediately decided that, in addition to the University of California at Berkeley, the Study should have a second center at Harvey Mudd College at Claremont, California.

This study, then, is a further part of the series which includes the Physical Science Study, the School Mathematics Study, the Biological Sciences Curriculum Study, the Teaching Resources Development in Geology Study, and the Chemical Bond Approach Project. It is felt that it will be supplemental to and not in any

sense competitive with the CBA project, and liaison has been set up from the very beginning.

Steering Committee

A Steering Committee, composed of leading educators interested in the teaching of chemistry and representatives from industry and government, was immediately organized with the gratifying result that acceptances were received from essentially all those asked to serve. The membership of the Steering Committee is given below. The first meeting of the Committee was held on January 9, 1960, in Berkeley, California and the objectives and an approximate time schedule were outlined. The important decision was made to attempt the production of a high school chemistry text and accompanying laboratory experiments in time for trial use in a few high schools during the academic year 1960-1961. This was admittedly an almost impossibly short time scale, but we feel that it was worth attempting in order to save a year in attainment of the ultimate objective. Events to date have shown that this gamble has proved successful. Further meetings of the Steering Committee were held during the spring and summer in order to guide the Study as it developed along the paths outlined.

The general objectives of the Study will be to develop new teaching materials for the high school chemistry course, including a textbook, laboratory experiments, and a laboratory manual, films, and supplementary reading materials. The more specific objectives will be to diminish the current separation between scientists and teachers in the understanding of science, to stimulate and prepare those high school students whose purpose it is to continue the study of chemistry in college as a profession, to encourage teachers to undertake further study of chemistry courses that are geared to keep pace with advancing scientific frontiers, and thereby improve their teaching methods, and to further in those students who will not continue the study of chemistry after high school an understanding of the importance of science in current and future human activities.

It was decided from the very beginning to have the high school chemistry course strongly based in experiment and to have the text thoroughly dependent upon and integrated into the laboratory experiments, with the supplemental use of integrated films wherever they might be helpful. Another basic tenet was to make the course applicable to the general student who takes high school chemistry rather than to the gifted or upper part of the typical high school class. It was proposed that the talented student be helped through the preparation of supplemental material for use in the text, perhaps as fine print and, more particularly, through the production of a series of special monographs.

Textbook

The rough draft of a text and the accompanying laboratory experiments will be used in twenty-four high schools during the academic year 1960-61. Teachers from these schools attended a four-week session at Claremont during the month of August in order to become acquainted with these materials. There will be weekly meetings of the teachers in the San Francisco and Los Angeles areas with

staff members of the CHEM Study in order to monitor progress, obtain information for revising the material, and continue to help each teacher to familiarize himself with the material.

Great emphasis is placed on the experimental nature of chemistry. Not only does this provide a basic understanding of science upon which succeeding courses can be built, it also gives a clear view of the way in which science advances. It leaves the nonscientist impressed, perhaps, but not mystified. It gives him respect for technological developments, but not dread or fear.

The course is begun with a novel and carefully ordered series of experiments which immediately engages the student in the basic activities of science. Then he is presented the atomic theory of matter as a working hypothesis — "a theory to be used but also to be thought about and criticized." The macroscopic chemical behavior of matter is explored and discussed in terms of the atomic theory, gradually and deliberately building up a substantial basis for belief in the atomic theory.

The periodic table is presented as the most important correlation in chemistry. The essential features of chemical change are emphasized as the heart of the course content: mass relationships, energy effects, time behavior and equilibrium in chemical reactions. Finally, a substantial amount of descriptive chemistry is surveyed in the light of the principles already developed.

* * *

Titles of Chapters in Text

1. Chemistry: An Experimental Science
2. Introduction to Atomic Theory
3. Atoms Combined in Substances
4. Chemical Reactions and Phase Changes
5. The Gas Phase: Kinetic Theory
6. Substances and Solutions
7. Chemistry and the Periodic Table
8. Geochemistry: The Earth as a Source of Material
9. A General View of Chemical Reactions
10. Energy Effects in Chemical Reactions
11. The Rates of Chemical Reactions
12. Equilibrium in Chemical Reactions
13. Ionic Solutions and Reactions
14. Acids and Bases
15. Oxidation-Reduction
16. Chemical Calculations
17. Believing in Atoms
18. Periodicity of Chemical Properties and Electronic Structure
19. Molecules and Their Structures
20. Structure in Solids and Liquids
21. The Chemistry of Carbon
22. The Halogens
23. The Transition Elements
24. The Third Row of the Periodic Table
25. The Second Column of the Periodic Table

* * *

Chapters 2 and 17 are given to illustrate the style as well as the approach.

INTRODUCTION TO ATOMIC THEORY

All of you have heard of chemical elements, atoms and molecules. Perhaps you have even learned some chemical formulas or have read about the structure of atoms. How are these related to the experiments you studied in Chapter 1? What have atoms to do with the way substances behave? Why do chemists believe in atoms? In this and later chapters you will learn why — it is because the atomic theory of matter helps us understand the facts we learn through laboratory experiments. You will learn through

your study of chemistry in each of its several activities. You will study the way the material of the earth behaves, organize the facts of this behavior, and seek reasoned and logical explanations of the regularities you find. One of the most important explanation in chemistry is the atomic theory. You will use this theory over and over in explanations of chemical facts. Every time you do, you will see more clearly why chemists believe in atoms.

Imagination and Chemistry

Stop reading for a moment and look at the paper rather than the printed words. The paper appears to be uniform in texture and to be all of one piece. Yet if you look at the paper through an optical microscope at a magnification of 100 diameters, you may see that it consists of tiny fibers matted together. If you now look at the paper again with the naked eye, you are able to visualize the microscopic structure of it. As chemists, we shall go one step further. After identifying the fibers as those of a substance, cellulose, we shall develop a submicroscopic view. We shall seek (and find) likenesses connecting the chemical systems which we study with a model system made up of very tiny particles called atoms. Thus we consider that the paper fibers are built up atoms, some called hydrogen atoms, some called carbon atoms, some called oxygen atoms. These atoms are bound together in definite, regular ways to form the material we see, cellulose fibers. This is an act of imagination, for we cannot see directly the atoms, nor their arrangement. But we shall see that this is a profitable act. There is a strong connection between the chemical world we sense and this model world we imagine. *The atomic model provides a "good" explanation of chemical behavior.*

How large are these minute particles called atoms? Experiments provide an answer—experiments we will consider later. About 100,000,000 of them, placed side by side, would extend about one inch in length. That *does* require imagination! Don't let that frighten you. You are already used to acts of imagination no less marvelous. Consider gases. Each of us uses his imagination when he thinks of gases. Looking at a candle burning, we see the flame, we see the wick, and we see the candle as it disappears. But we do not see the gaseous oxygen that is used up nor the gaseous carbon dioxide and water vapor (gas) that are formed. The particles of these gases are too small to be seen with an optical microscope or an electron microscope. Yet we are convinced that water *is* formed because we can collect gas from the flame and condense liquid water from it. Because of other experiments we are convinced that oxygen actually *is* used up and that carbon dioxide is formed. We have no difficulty thinking about these gases, though it requires imagination.

All persons do some imagining. You, as a chemist, should do something more. You should test your imagining by seeking whether it agrees with or conflicts with the observed facts. The trick is to imagine as well as to observe and then to compare the imagined situation with the actual facts.

The Atomic Theory

Each person must do his own thinking and his own imagining. Yet,

chemistry is not a private science, different for each person. Through the years many chemists have published experimental facts they have discovered and the ideas they have formulated to explain the facts. The ideas are usually expressed in verbal statements (but sometimes in the form of mathematical statements). Such statements we call *theories*. Some theories are proposed on the basis of only a little experimental evidence and develop slowly over many years. Not all theories are adopted by all other chemists but many theories are widely accepted and they remain in use until better ones are proposed. Usually the theories which fit the facts best or which apply to the largest number of cases are retained, but even these theories are likely to be revised from time to time.

Atomic theory furnishes good examples. Chemists today interpret all chemical behavior in terms of atoms and of the electrons and nuclei which make up the atoms. Atoms may seem real to you because you have heard the word "atom" so often. Atoms seem real to chemists because chemists have seen so much experimental evidence best explained by the atomic theory. Both you and the professional chemists, however, feel more certain that atoms exist than about the details of the structure of atoms, and feel surer about some details than about others. By the time you have finished this course you will have studied much of the evidence for our current views about atoms. In the meantime, you should look upon the atomic theory as a theory to be used but also as one to be thought about and criticized. In this way you learn how useful it is to us and, at the same time, you learn its limitations. Every theory should be judged on these qualities, usefulness and limitations. Learn to evaluate them.

Elements and the Atomic Theory

In the years 1802 to 1804, John Dalton, an English chemist and physicist, proposed that the chemical elements consist of tiny particles which cannot be divided or created. These particles he called atoms. He proposed further that the atoms of each element are alike and that they differ from the atoms of every other element. Dalton based his theory on the behavior of only a few of the elements so that his original list of atoms and their weights was rather short.

Since Dalton's time many more elements have been discovered; now more than one hundred are known. Yet we still believe that elements consist of atoms and that the atoms of each element are alike in certain important respects. True, new evidence has forced us to abandon some of Dalton's views (he thought all atoms of a given element have exactly the same weight, but experiment shows this is false) but we still make use of his atomic postulate. This is the way a theory grows. The theory leads us to try new experiments. The new experiments furnish new facts. On the basis of these new facts we retain the theory or modify it as necessary.

Scientific Models

When a physical scientist uses the term "model" he often means an actual object constructed of wood, cork, styrofoam, or metal, for example, a model of a water molecule. Such a

model helps us visualize a water molecule even though we know the actual atoms are not made of wood, cork, and so on, are not "solid," and do not have sharply determined surfaces.

Sometimes models are pictures, line drawings, or formulas (H—O—H) just as a house may be represented by a set of "floor plans" and "elevations." Often scientists use the term model to mean a statement or series of statements. When these statements are in words, we often try to visualize them by thinking of them in terms of things we can see and handle. Sometimes scientists use mathematical statements rather than verbal statements. Such statements are still more abstract and difficult to visualize, but mathematical models are often needed. For example, a rubber model of an atom cannot really represent the electrons which "fill" most of an atom; two rubber balls colliding cannot show exactly what happens when two atoms collide with each other. We shall use many kinds of models in this course. They will help you to visualize many chemical happenings but you should not think that the models themselves completely describe atoms and molecules.

An Atomic Model — The Nuclear Atom

Since atoms are too small to be seen, we develop our ideas about their nature and their structures form the results of experiments in which we measure the effects they produce under different circumstances. The experiments permit us to make a number of statements (including mathematical statements) about atoms. In this way we build up an atomic model step by step and with varying degrees of certainty.

Since the elements have definite properties, we assume that all the atoms of an element must be alike in their characteristics which lead to these properties. The atoms of different elements must differ. Are they so unlike that we must set up a different kind of atomic model for each element? The answer is no. We find that we can use the same kind of model for all atoms.

We can obtain electrons from all kinds of atoms. As you know, an *electron* is a tiny particle carrying an electric charge which is the same for every electron. This charge is arbitrarily called "negative" to distinguish it from another kind of electric charge we arbitrarily call "positive." We know no smaller charge than the charge of the electron and all larger negative charges are integral multiples of the electron charge. That is, the larger negative charges are 1 or 2 or 3, and so on, times larger than the electron charge. Therefore we designate the charge of the electron as one unit of charge, and we call it 1— to indicate that it is negative.

Since mass is associated with all matter, it is natural to assume that the atoms (that form the material) also have mass. And since each sample of matter occupies a certain volume we can also assume that each atom in this sample occupies a region of space which we call the volume of the atom. Experiments on atoms show that each atom does have a measurable mass but that almost all the mass of the atom is concentrated in a region much smaller than the

volume of the atom. This region we call the *nucleus* of the atom.

Experiments also show that the nucleus carries an electric charge of the kind we have called positive. The element hydrogen has the lightest atoms, and the nuclei of these atoms have the smallest charge. In fact, the positive charge of the hydrogen nucleus, called the *proton,* exactly counteracts the effect of the electron charge. The electron and the proton together produce an electrically neutral system — one with no charge. Hence, we designate the proton charge as 1+. All other positively-charged particles have charges equal to an integral multiple of the proton charge — for example, 1+, 2+, 3+, and so on. The nuclei of all atoms have such positive charges.

In general, matter is electrically neutral. The atoms themselves have electrically-charged parts — (a) a nucleus having a positive charge, 1+, 2+, or 3+, and so on, and (b) one, two or three, and so on, electrons each having a negative charge of 1—. A neutral atom has enough electrons around its nucleus to exactly balance the positive charge of the nucleus. This is our general model of the atom — a "nucleus" surrounded by electrons. The experiments which have led to this model are discussed in Chapter 17.

BELIEVING IN ATOMS

In Chapter 2 you were introduced to atoms. You were told that the atom contains charged particles, that it has a nucleus made up of neutrons and protons, and that the nucleus is surrounded by electrons. The atom is incredibly small but the nucleus is even smaller. Then you were told that the atomic theory, as with every other theory, should be thought about and criticized. It is one thing to ask "Do we believe in atoms?" and quite another to ask *"Why* do we believe in atoms?" In this chapter, we shall try to answer this last, harder question.

Let's begin with an unpretentious example which shows how we make such decisions in day to day life.

A new tenant is told by his neighbor that the garbage collector comes every Thursday, early in the morning. Later, in answer to a question from his wife about the same matter, the tenant says "I have been told there is a garbage collector and that he comes early Thursday morning. We shall see if this is true." The tenant, a scientist, has accepted the statement of the neighbor (who has had opportunity to make observations on the subject). However, he accepts it *tentatively* until he, himself knows the evidence for the conclusion.

After a few weeks, the new tenant has made a number of observations consistent with the existence of a Thursday garbage collector. Most important, the garbage does disappear every Thursday morning. Second, he receives a bill from the city once a month for municipal services. And there are several supplementary observations that are consistent — often he is awakened at 5:00 A.M. on Thursdays by a loud banging and sounds of a truck. Occasionally the banging is accompanied by gay whistling, sometimes by a dog's bark.

The tenant now has many reasons to believe in the theory of garbage collectors. Yet he has never seen a garbage collector! As a curious man,

he might set his alarm one Thursday morning to ring at 5:00 A.M. Looking out the window, he sees, first, that it is surprisingly dark out and difficult to see. Nevertheless, he discerns a shadowy form pass by, a form that looks like a man carrying a large object.

Seeing is believing! But which of these pieces of evidence really constitutes "seeing" the garbage collector? Which piece of evidence is the basis for "believing" there is a garbage collector? The answer is, that *all* of the evidence taken together, constitute "seeing." And *all* of the evidence taken together, furnish the basis for acceptance of the "garbage collector theory of garbage disappearance." The direct vision of a shadowy form at 5:00 A.M. would not constitute "seeing a garbage collector" if the garbage didn't disappear at that time. (It might have been the paper boy or the milkman.) Neither would the garbage disappearance alone consist of "seeing" the garbage collector. (Perhaps a dog comes by every Thursday and eats the garbage. Remember, a dog-bark was heard!) No, we are convinced there is a garbage collector because the assumption is consistent with so many observations, and it is inconsistent with none. Other possible explanations fit the observations less ably (the tenant had never heard a dog whistle gaily). The garbage collector theory passes the test of a good theory — it is useful in explaining a large number of experimental observations. This was true even before the tenant set eyes on the shadowy form at 5:00 A.M.

Yet we must agree, there are advantages to the "direct vision" type of experiment. Often more detailed information can be obtained this way. Is the garbage collector tall? Does he have a moustache? Could the garbage collector be a woman? This type of information is less easily obtained from other methods of observation. It is worthwhile setting the alarm, even after we have become convinced there is a garbage collector.

At the beginning of this course, you were a new tenant. You were told chemists believe in atoms and that you should accept this proposal tentatively until you, yourself, know the evidence for it. Since that time, we have used the atomic theory continuously in our discussions of chemical phenomena. The atomic theory passes the test of a good theory it is useful in explaining a large number of experimental observations. We have become convinced there are atoms.

Now we are going to review the types of evidence which form the basis for belief in the atomic theory. We shall place emphasis on those experiments which are closest, in concept, to the "direct vision" type. These are particularly convincing and they provide detailed information which is less readily obtained in other ways.

Chemical Evidence for the Existence of Atoms

Let us begin by looking again at the evidence we already have for the existence of atoms — the evidence from chemistry. Early in this course we found that each chemical compound has a fixed and definite composition. Whenever and wherever water is decomposed into its elements, eight grams of oxygen for every gram of hydrogen is always the result. All

attempts to synthesize water with different composition fail; the composition of the water from any mixture of hydrogen and oxygen under any conditions is always the same.

The atomic theory provides an explanation for the definite composition of chemical compounds. It says that compounds are composed of molecules, and every molecule of a given compound must contain the same number of atoms of each of its elements. Since the atoms of each element have a characteristic weight, the weight composition of a compound is always the same. (This statement is true if the naturally occurring distribution of isotopes is not disturbed.)

In some cases, two elements brought together under different conditions can form two or more different compounds. In addition to water, hydrogen and oxygen can form a compound called hydrogen peroxide (H_2O_2) in which the weight of hydrogen is $\frac{1}{16}$ the weight of oxygen in the compound. This weight ratio in water is $\frac{1}{8}$, exactly twice as large. What a simple relationship! The weight ratio is one to sixteen in one compound of hydrogen and oxygen and one to eight in another. Such simple numerical relationships are always found among different compounds of any pairs of elements. It is explained very clearly within the atomic theory. Each molecule of hydrogen peroxide contains two atoms of hydrogen and two atoms of oxygen. The ratio of the number of hydrogen atoms to oxygen atoms is $2/2 = 1$. In contrast, a molecule of water contains two atoms of hydrogen and only one atom of oxygen. The ratio of hydrogen atoms to oxygen atoms is $2/1 = 2$. Since there are twice as many hydrogen atoms per oxygen atom in water as in hydrogen peroxide, of course the weight ratio of hydrogen to oxygen in water is twice that in hydrogen peroxide.

In general, different compounds of the same two elements have different atomic ratios. Since these atomic ratios are always ratios of integers, 1 to 1, 1 to 2, 2 to 1, 2 to 3, etc., the weight ratios will be simple multiples of each other. Thus the atomic theory explains the observation that different compounds of the same two elements have relative compositions by weight which are simple multiples of each other.

This success of the atomic theory is not surprising to an historian of science. *The atomic theory was first deducted from the laws of chemical composition.* In 1806 John Dalton wondered why chemical compounds have definite composition. He proposed that perhaps each element consists of discrete particles, and each compound is composed of molecules which can be formed only by a unique combination of these particles. Suddenly many facts of chemistry became understandable in terms of this proposal. The continued success of the atomic theory in correlating a multitude of new observations accounts for the fact that the atomic theory has survived. Today, many other types of evidence can be cited to support the atomic postulate but the laws of chemical composition still provide the cornerstone for our belief in this theory of the structure of matter.

Chemical Evidence for the Electrical Nature of Atoms

You have heard that the atomic

nucleus bears a positive charge and is surrounded by a number of negatively charged particles called electrons. Also, the nucleus is supposed to contain most of the mass of the atom. It is made of protons and neutrons, each of which has nearly two thousand times the mass of the electron. How do we know that atoms are built this way? How do we know that there is such a particle as an electron? Again, weight relations associated with chemical reactions provide key evidence.

In Chapter 15 we discussed the operation of a battery. We successfully interpreted the chemical changes brought about by the movement of electrical charge in terms of the atomic theory. To understand the full impact of these experiments on the development of the atomic theory, we must turn back the scientific clock to the views held in the 19th century. When Michael Faraday first performed his electrolysis experiments (in the early 1830's), the atomic theory had been proposed, but no one had yet suggested the existence of electrons. There was no reason to suspect that electricity consisted of discrete particles. Faraday observed that the quantity of electricity necessary to deposit a given weight of an element from solutions of its different compounds was always equal to a constant, or some simple multiple of this constant. For example, the amount of electrical current which will deposit 3.75 g of metallic mercury from a solution of mercuric perchlorate, $Hg(ClO_4)_2$, will deposit the same number of grams of mercury from a solution of mercuric nitrate, $Hg(NO_3)_2$. On the other hand, this same amount of electricity will deposit exactly twice as much mercury, $2 \cdot (3.75) = 7.50$ g, from a solution of mercurous perchlorate, $Hg_2(ClO_4)_2$. If we restate Faraday's experimental finding in terms of the atomic theory, we see that the number of atoms of mercury deposited by a certain quantity of electricity is a constant or a simple multiple of this constant. Apparently this certain quantity of electricity can "count" atoms. A simple interpretation is that there are "packages" of electricity. In an electrolysis, these "packages" are parcelled out, one to an atom, or two to an atom, or three.

The second of Faraday's results was that the weights of different elements which were deposited by the same amount of electricity were found to be in simple ratios of the atomic weights of these elements. Within the atomic theory, this statement means again that a certain amount of electricity will deposit a fixed number of atoms, or some simple multiple of this number, *whatever the element.* Again we find that an atom can carry only a fixed quantity of charge, or some simple multiple of this quantity. Therefore, electrical charge comes in packages. An atom can carry one package, two packages, possibly three packages of charge, but not 1.5872 packages. Whatever the package of charge is, it is the same for all atoms. The realization that electrical charge comes in packages led to the proposal that electricity must be composed of particles. Since atoms carry electrical charges, atoms must contain these particles.

* * *

Lab Manual

One of the important features of the CHEM Study course is its em-

phasis on experiments carried out by students. When one tries to teach ideas which are not firmly based on experiments, the students usually have great difficulties, but as long as one sticks to experiments and discusses them in detail, students can learn. It is our opinion, that almost any topic, even though it may appear a bit sophisticated in terms of current practice, may be presented to high school students if it is introduced by an appropriate experiment.

The students go into the laboratory on the first day and are asked to observe a burning candle. The student writes as many observations as he can in ten minutes, after which the teacher points out the difference between experimental observations, and the assumptions or interpretations made by the student. For example, if the student states that there is a pool of liquid wax at the bottom of the flame, it is pointed out that this is merely one interpretation of his observation and he is asked to go into the laboratory to get some direct evidence concerning the nature of this liquid. This leads to melting point as a criterion for identifying a solid, to considerations of change of state, plotting a cooling curve, the reason for the flat portion of the curve, and calculation of the heat of fusion.

On succeeding days, the student makes observations relating to the chemical reactions involved in the burning candle and then measures the heat of combustion. During the first few weeks, the students have averaged 3 periods per week in the lab and their initial reaction to this emphasis has been favorable.

Many of the experiments are quantitative and involve a triple beam balance with a precision of $\pm$ 0.01 g. Here again the initial experience has been quite favorable and justifies our assumption that a teenager who can tinker successfully with a model airplane, or knit a pair of argyle sox is no more handicapped by "too many thumbs" at age 16-17 than he or she may be as a college freshman a year or two later.

In order to help the students develop good habits of keeping records of experiments, each is provided with a specially designed notebook containing two colors of squared paper. A carbon copy is submitted to the instructor and eventually to the CHEM Study staff for use in making evaluation of the experiments for future revisions. At first, models of well organized tables for data and calculations are provided but gradually more and more is expected of the student by way of organization.

Techniques are demonstrated and safety precautions stressed at the point where they are first needed in an experiment — not in a big dose at the beginning of the year.

In general, the maxim, experiments first — discussion later, is followed throughout the course. For example, early in the year the student discovers the value of the term "mole," and the necessity of conserving both atoms and charge in balancing an equation by doing a simple quantitative experiment involving the reaction of a copper wire with a solution of silver nitrate. From the number of moles of copper dissolved and moles of silver deposited he can then balance the equation and insert the proper positive charges on the ions.

It is hoped that this experimental approach — which is the way chemists actually operate — will continue to be as popular with other trial teachers as it has been with our present group, and that it will eventually result in the return of the two-period laboratory session in many high schools.

* * *

List of Experiments For the First Semester

Introduction: Observation and Description Experiment

1. Melting Points
2. Chemical Reactions of a Burning Candle
3. Heat Effects
4. The Reaction of Solid Copper With a Solution of Silver Nitrate

4a. The Empirical Formula of Silver Chloride

5. Construction of Some Molecular Models
6. Mass Relations in a Chemical Reaction
7. Determination of the Formula of a Hydrate
8. Comparing the Weights of Gases
9. A Comparison of the Boiling Points of a Pure Liquid and a Solution
10. Some Aspects of Solubility
11. Quantitative Determination of Solubility and Construction of a Solubility Curve
12. Reaction Between Ions in Solution
13. The Density of Hydrogen
14. A Study of Reactions
15. Heats of Reaction
16. Study of Reaction Rates
17. Chemical Equilibrium
18. A Study of Indicators
19. Cells (to accompany a demonstration)
20. Ionic Reactions
21. Quantitative Titration

* * *

Experiment 10 is given to illustrate the style and approach used.

SOME ASPECTS OF SOLUBILITY

Introduction: Differences in solubility serve as clues to the structure of substances. They provide a way of identifying substances, and often make possible the separation and purification of substances. Such differences therefore deserve our careful attention. Although it is impossible to observe all the phenomena associated with solubility in the limited time available, we can direct our attention to a few examples from which it is possible to make some useful generalizations.

Procedure:

Part I: Liquid-liquid Miscibility

Accurate measurements of volume are unnecessary in this experiment. Observe the approximate volume of 2 ml and of 3 ml in a small test tube. You may want to set a small test tube to one side with these volumes indicated until you get used to the amount involved.

a. Place four small test tubes in a test tube rack. Place 2 ml of water in the first, 2 ml of methanol, formula CH_3OH, in the second, 2 ml of benzene, formula C_6H_6, in the third and 2 ml of carbon tetrachloride, formula CCl_4, in the fourth. Add 1 ml of water to each tube. Mix and record your observations.

b. Clean the test tubes and prepare a second set of four as above but this time add 1 ml of methanol to each.

c. Repeat using 1 ml of benzene.

d. Repeat again using 1 ml of carbon tetrachloride.

Part II: Solubility of Solids in Various Liquids

In this experiment you will be concerned with the general extent of solubility and not with quantitative measurements. It is important to realize that even when a solid is apparently insoluble, there are always some molecules (or ions) that have gone into solution. We will consider a substance to have negligible solubility if so little dissolves that it is not apparent from visual observation.

Since you are to test the solubility of several substances in each of the solvents, it will be best to mark one tube for use with each solvent. This tube may then be rinsed with a little of the solvent after use but will not need to be dried as it would if different solvents were being used in it.

Place four small test tubes in a rack and add 3 ml of water to the first, of methanol to the second, benzene to the third, and carbon tetrachloride to the fourth. Add a small portion of one of the solids from one of the groups listed below to each of these. As a small portion you may estimate a volume of about $\frac{1}{4}$ ml except in the case of iodine. Of iodine use only a tiny crystal about the size of a pencil lead (1 mm long).

Rinse the tube and repeat the above with the other four solids in the same group below.

Record observations on an appropriate chart.

Use the iodine last of the five and save these solutions for Part III.

Group 1	Group 2
copper sulfate	potassium chloride
cane sugar	*para*dichlorobenzene
marble chips	sodium chromate
stearic acid	sulfur
iodine	iodine

Group 3	Group 4
magnesium sulfate	sodium bicarbonate
charcoal	lead sulfate
naphthalene	benzoic acid
piece of candle	lard or butter
iodine	iodine

Part III: Using Differential Solubility to Effect a Separation

Procedure: To the test tube containing water and iodine, add 10 more ml of water or if this tube has not been saved prepare a mixture of about 12 ml water and a little iodine. Shake thoroughly. Decant 3 ml of the water into another test tube. Decant another 3 ml into a second tube and a final 3 ml into a third tube. (Leave the undissolved portions in the original tube.) To the first of these add 1 ml methanol, to the second 1 ml benzene and to the third 1 ml carbon tetrachloride. Shake each.

Pour $\frac{1}{2}$ ml of the methanol-iodine solution into each of 2 test tubes. Dilute this with 5 ml water. Add 2-3 ml of benzene to one and 2-3 ml carbon tetrachloride to the other. Shake well.

Organizing the Information Collected

1. Make a chart indicating the miscibility of the liquids in Part I.

2. Did you observe anything about the density of these liquids while doing the experiment? Explain.

3. Would the proportion of the two liquids make any difference in their solubilities? Suggest further investigations to throw light on this observation.

4. Examine the chart you have made for Part I and compare the results from the group of solids you

used with the results others have obtained for the other groups. What generalizations may be made?

5. Suggest a method by which you could investigate the solubility of these substances in a quantitative way.

6. Explain the problems involved in attempting to remove all of the iodine from a water-alcohol solution of iodine by using benzene or carbon tetrachloride.

7. Suggest a specific example to illustrate how differences in solubility might be used

a. as a clue to the structure of a substance

b. to provide a way of identifying a substance

c. to provide a way of separating a mixture of two substances.

NOTE: It is important to realize that in this experiment we have considered only some aspects of solubility. The interactions between the solvent and solute vary from simple to extremely complex and must be taken into account for a more complete understanding.

* * *

Future Plans

The initial task of the CHEM Study — producing materials for trial in a small number of secondary schools and the 1500 students now using the materials are providing a broad test of the first text and of the laboratory experiments. But already the queries arise — when will these materials, if they are successful, be widely available to all who wish to use them? The current best estimate is the fall of 1963.

Weekly meetings of the teachers currently using the materials are now providing the staff with suggestions for revisions, deletions, and amplifications. In fact, four of the staff are actually teaching the course in two of the high schools in order to get even more direct experience with problems as they arise. Revisions are underway based on these direct observations, the reports of the teachers, and the written laboratory reports of the students. A unified testing program will attempt to measure the degree to which student response is meeting the goals of the program.

Textual revisions will be further studied, and an intensive rewrite undertaken, during the summer of 1961 at the University of California at Berkeley under the editorship of George Pimentel. Similarly the laboratory experiments will be revised under the editorship of Lloyd Malm at Harvey Mudd College.

Summer Institutes

There will be two Summer Institutes in 1961; one at Cornell University, and one at Harvey Mudd College, where approximately an additional one hundred secondary school teachers will become acquainted with these revised materials. Announcements concerning the Institutes will be included in the National Science Foundation brochure to be distributed in January, 1961.

Most of the teachers will come from nine geographical areas which will serve as the main trial centers during 1961-62. Teachers within each geographical area will again meet weekly with a local staff member of the study to provide as close a contact as possi-

ble with student reaction to the course through 1961-62. The nine geographical areas will be New York City, Philadelphia, Northern Florida, Central Indiana, Chicago, Minneapolis, Seattle, San Francisco, and Los Angeles. In addition, a certain number of "solo" teachers in single high schools will be scattered across the country. These teachers will be trying the materials without participating in the weekly meetings characteristic of the centers.

A third rewriting of the material will be undertaken during 1961-62 with particular emphasis on producing, by the end of the summer of 1962, a final version for printing in regular book form, rather than in photo-offset as used with the earlier versions. This book version should be available to all interested high schools in the fall of 1963.

Additional Summer Institutes will be held in 1962 and 1963, to obtain further reaction from teachers and to allow a final trial of the semi-finished materials before they are generally distributed. Our rough estimate would indicate that about 500 to 1000 teachers will have had an opportunity to look over the materials during a Summer Institute before the fall of 1963. We do not feel that such preliminary perusal is mandatory for successful use of the course, but our own slight experience, as well as that of curriculum revision groups active in other fields, would indicate such summer work constitutes a definite advantage.

Additional Volumes

Three further types of volumes are also contemplated by the fall of 1963: (1) a teachers' guide to accompany both the text and laboratory manual, (2) a set of classroom experiments to emphasize the experimental nature of the science and to amplify the laboratory work, and (3) a set of monographs designed for the abler students or the teachers with special interests, to allow thorough exploration of limited fields closely related to, but not covered by, the basic text.

Films — both motion pictures and filmstrips — and other aids to teaching also will be available to constitute a closely integrated means of further enhancing classroom contact with the wide scope of chemistry.

The intent of the CHEM Study is to produce as effective materials as possible for a first course in chemistry. These materials will be designed to be assimilable by any student who would normally elect chemistry at this level. We recognize that perhaps half of these students will have no further formal contact with science, whereas many of the rest will go on to college courses and even to professional careers in chemistry. Thus, the course must serve as an honest presentation of contemporary chemistry for those whose interests lie in this direction, and at the same time, provide a broad educational base for those whose only contact with a physical science will be found here.

The Staff, located at Harvey Mudd College in Claremont, consists of: the Director of the CHEM Study, J. Arthur Campbell; Assistant Director and Editor of the Laboratory Manual, Lloyd E. Malm; Film Producer, David W. Ridgway; and Staff Consultant, Joseph E. Davis. The Staff at the University of California at Berkeley consists of: Assistant Director and

Editor of the text, George C. Pimentel; Staff Contributor, A. L. McLellan; and Staff Consultant, Margaret Nicholson.

* * *

Steering Committee

Dr. Glenn T. Seaborg, University of California, Berkeley.

Dr. J. A. Campbell, Harvey Mudd College, Claremont.

Dr. Bryce Crawford, Jr., University of Minnesota.

Mr. Warren Everote, Encyclopaedia Britannica Films, Wilmette, Ill.

Dean Henry Eyring, University of Utah.

Mr. W. H. Freeman, W. H. Freeman and Company, San Francisco.

Mr. Rolland Gladieux, Kenmore High School, Buffalo, N. Y.

Mr. Cleveland Lane, John Sutherland Productions, Inc., New York, N. Y.

Regent Donald H. McLaughlin of the University of California, San Francisco.

Dr. Carl G. Nieman, California Institute of Technology.

Dr. J. Cecil Parker, University of California, Berkeley.

Dr. Charles C. Price, University of Pennsylvania.

Dean Kenneth S. Pitzer, University of California, Berkeley.

Mr. Robert Rice, Berkeley High School, Berkeley.

Mr. Robert Silber, American Chemical Society, Washington.

Dr. Grant Vest, Coordinating Council of Higher Education in Utah.

Dr. Roy L. Whistler, Purdue University.

Contributors

Contributors, in addition to the staff, who wrote the text book and laboratory manual during the six-week session from June 18 to July 30, are listed below:

Robert F. Campbell, Miramonte H.S., Orinda, Calif.

Saul L. Geffner, Forest Hills H.S., Forest Hills, New York

Theodore A. Geissman, University of California, Los Angeles, Calif.

Melvin Greenstadt, Fairfax H.S., Los Angeles, Calif.

Edward L. Haenisch, Wabash College, Crawfordsville, Indiana

C. Robert Hurley, Sacramento State College, Sacramento, Calif.

Keith MacNab, Sir Francis Drake H.S., San Anselmo, Calif.

Bruce H. Mahan, University of California, Berkeley, Calif.

Margaret Nicholson, Acalanes Union H.S., Lafayette, Calif.

Clyde E. Parrish, Cubberley Senior H.S., Palo Alto, Calif.

Robert W. Parry, University of Michigan, Ann Arbor, Mich.

Michell J. Sienko, Cornell University, Ithaca, N. Y.

Robert Silber, American Chemical Society, Washington, D.C.

Luke E. Steiner, Oberlin College, Oberlin, Ohio

Robert L. Tellefsen, Napa H.S., Napa, Calif.

Number of Science Doctorates Increasing

➤ THE NUMBER of doctor's degrees awarded in the United States during the year 1959 reached an all-time high of more than 5,300.

The average age of these new doctorate holders was 31½ years when they received their degree. The average period from the bachelor's degree to the doctorate was 8.1 years. Chemistry doctorates were highest, with 1,062 doctorates awarded during 1958 and 1959, it was found in a study by the National Academy of Sciences - National Research Council and reported by the National Science Foundation. The report is "The Science Doctorates of 1958 and 1959, Their Numbers, Characteristics and Employment."

Apparatus Article

Chromatography Laboratory

➤ A MULTIPLE strip desktop chromatography laboratory capable of running up to six different solvent systems simultaneously is now available from Microchemical Specialties Company, Berkeley, California.

Developed by Dr. Harold T. Gordon of the University of California, this compact chromatography laboratory produces 1-dimensional ascending or descending paper strip chromatograms within 1 to 2 hours. It is con-

venient for both single and multiple experiments.

The Gordon-Misco apparatus is designed specifically for ease of operation. It consists of six glass tubes 15 inches long and 2 inches in diameter with separate sets of glass cups for ascending and descending chromatography. Cups can be cleaned and solvents changed in a few seconds.

Construction throughout is airtight, solvent-proof glass and polyethylene.

The tubes use ½, 1 or 1½ inch wide paper strips. Each tube is a completely isolated operation to prevent solvent contamination. Minimum solvent volumes are required (normally 5 ml), yet the high ratio of solvent to air space results in constant Rf values.

Easily assembled and disassembled, the Gordon-Misco unit can be set up for use in a few minutes. It requires only 11¾ x 5¼ inches of desk space and fits into a small laboratory drawer when disassembled.

Price of the Gordon-Misco laboratory is $125. For additional information, please write to Microchemical Specialties Company, 1825 Eastshore Highway, Berkeley 10, California.

Polluted Waters a "Disgrace"

➤ THE NATION'S polluted waters are "a disgrace," Surgeon General Leroy E. Burney told delegates at the first National Conference on Water Pollution.

Dangerous pollutants cited by Dr. Burney include sewage, chemicals that kill microbes but may be toxic to humans or fish, ionizing radiations, lead from agricultural sprays and auto exhausts.

The Federal Government has been concerned about dirty water since 1913, Dr. Burney said. Today its main research center, The Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, has teams of experts working on freeing water supplies from viruses and bacteria, detergents, insecticides and radioactive contaminants.

They also have developed a pilot sewage treatment procedure suitable for housing subdivisions beyond reach of city sewer systems.

The Public Health Service, Dr. Burney said, has 75 stations where interstate waters are sampled. PHS also keeps tabs on how many facilities are dirtying the water, how many are cleaning it up and how much it is costing the taxpayer.

When pollution in one state endangers another, the Surgeon General and the Secretary of Health, Education and Welfare can take action to abate pollution. Thirteen enforcement actions have been taken, and only one case, in St. Joseph, Mo., has required Federal court action.

In calling for cooperation, Dr. Burney said, "the most fundamental responsibility of all rests at the source — with the municipalities and industries concerned. Clearly too, the states must continue to be keystones of our pollution control efforts. Historically, legislatively and logically the strength of the state agency is a major determinant of success in pollution abatement."

Science Institute Endorsed

➤ THE CREATION of an international institute of science and technology in western Europe, proposed by Rep. Victor L. Anfuso (D-N.Y.), was endorsed unanimously by the North Atlantic Treaty Organization's Parliamentarian Conference recently concluded in Paris.

The institute will provide free training and research opportunities for students from the North Atlantic countries and the underdeveloped nations of the world for peaceful exploration of outer space, oceanography, meteorology, communications and other areas of scientific discipline.

"Its establishment is mandatory upon the free world," he said, "especially now that the Soviets are offering a free education plus living and travel expenses to students all over the world to attend their so-called Friendship University.

This offer is profoundly appealing, particularly to the youth in the underdeveloped areas of the world, and is extremely effective in promoting the Communist way of life."

The international institute under NATO will promote western ideals of liberty and democracy by offering training in an atmosphere of freedom.

"It also will help dispel the idea that NATO is strictly a military alliance," he said, "and will promote world peace."

War may be eliminated "by the eventual creation of a world of abundance," he said. "This pooling of resources for peaceful purposes may help create such a world."

Rep. Anfuso, a member of the U. S. Congressional delegation to the NATO Conference, headed by Vice President-elect Lyndon B. Johnson, credited Sen. Henry Jackson (D-Wash.) with originally suggesting such an institute. Sen. Jackson is a former chairman of the NATO Science and Technology Committee.

On the Back Cover

➤ THE BACK COVER *shows the largest rectangular aluminum ingot ever made. It has been cast by the Reynolds Metals Company's sheet and plate plant for use in the company's program to build the Aluminaut — the aluminum research submarine designed to explore the ocean's depths three miles down. Inspecting the 31,750 pound ingot, measuring 26 X 72 X 180 inches are John Larson, McCook plant manager, (left), and V. M. (Max) Gray, plant cast house superintendent. The ingot will be forged into the first of several cylindrical rings which when joined together will form the submarine's 48-foot long hull. Aluminum is believed to be the only practical material strong enough to resist the external pressures at super-depths. A similar-sized steel hull would be too heavy to return to the surface.*

Proudly Presented

Announcing new developments in the chemical industry and newly available chemical literature.

New Synthetic Rubber For Auto Tires

➤ THE DEVELOPMENT of a new type of rubber for tires and other applications, from raw materials in plentiful supply, was revealed by Lyle O. Amberg, Hercules Powder Company chemist, to a session of the 138th meeting of the American Chemical Society in New York City.

Emphasizing that the new Hercules EPR (ethylene-propylene rubber) was still in a laboratory stage, Mr. Amberg stated that considerable research showed the new rubber appeared to meet or exceed many of the important properties of SBR, natural rubber, butyl, and other large-volume commercial elastomers.

Interesting features of EPR listed by the Hercules chemist included:

Outstanding ozone and weathering resistance;

excellent wear resistance;

projected commercial price in the general-purpose range.

"The laboratory work indicates that EPR passenger tire treads should be resistant to wear and groove-cracking," the Hercules chemist said. "Sidewalls should be ozone-proof; white sidewalls should have excellent color and resistance to discoloration."

Other potential applications for Hercules EPR included: mechanical goods, power and conveyor belting, wire coating, household items, drug sundries, shoe soles and heels.

The new rubber is an outgrowth of Hercules' pioneering research work in Ziegler polyolefin chemistry, which previously led to the first commercial production in the United States of polypropylene plastic by Hercules. Hercules also was one of the early producers of high-density polyethylene.

Raw materials for the new rubber are propylene and ethylene, which are obtained from oil refinery operations and are in plentiful supply.

Because of the unusual saturated character of EPR, another Hercules product, "Dicup" dicumyl peroxide is used in the curing system and appears to yield vulcanizates with the best balance of properties.

In the report, the first major one on this subject by an American company, the Hercules chemist pointed out that by varying the amount of ethylene and propylene, polymers can be made which range from soft buttery salves through typical elastomeric rubbers to tough semirigid products.

Samples of the new rubber are in the hands of American rubber companies, Mr. Amberg said.

The report was a joint effort of Mr. Amberg and Dr. A. E. Robinson of Hercules Research Center, near Wilmington, Delaware.

Lactonitrile Aids Hydrocarbon Separation

➤ LACTONITRILE, a bifunctional chemical that has potential as a selective solvent and as an intermediate, is now

available in development quantities from the petrochemicals department of American Cyanamid Company.

A selective solvent for olefinic hydrocarbons, lactonitrile has unique solvent characteristics that make it an interesting tool for the vapor-phase separation of hydrocarbon mixtures of narrow boiling-point range. In the processing of hydrocarbon mixtures, for example, the solvent properties of this chemical may be used to separate unsaturated from saturated hydrocarbons and, more specifically, diolefins from mono-olefins and paraffins.

Because of its two functional groups, lactonitrile is a useful chemical for the preparations of a variety of products. A few interesting examples are lactic acid, ethyl lactate, 5-methylhydantion, 1-cyanoethyl vinyl ether, α-sulfatopropionamide and α-anilinopropionitrile.

Lactonitrile undergoes the reactions of an alcohol, which include ammonolysis, acylation, dehydration and reactions with diazomethane. With fatty amines, it reacts to produce amino acids with unusual surface active properties. Good wetting power is a property of the material produced by hydrolyzing the reaction product from lactonitrile and dodecylamine. The corresponding hydrolysis product from the reaction of cocoamine with lactonitrile is suggested for use in detergent formulations.

Through its nitrile group, lactonitrile can enter into such reactions as hydrolysis, alcoholysis, reduction, esterification reaction with Grignard reagents and the Houben-Hoesch synthesis. Esterifications of lactonitrile with alcohols and acids produces materials that have potential as plasticizing agents.

Other commercial possibilities for this chemical include its use to produce a filler for such nitrile-containing plastics materials as acrylonitrile polymers and nitrile rubber. Small concentrations of lactonitrile have been reported to retard the oxidation of styrene appreciably. It has also been used as an organic cyanide brightner in the electrodeposition of nickel.

Samples and technical information can be obtained from the petrochemical department, American Cyanamid Company, 30 Rockefeller Plaza, New York, 20, N. Y.

New High Speed Tool Steel

➤ The Crucible Steel Company of America has developed a new grade of high speed steel designated Rex 49, designed to provide greatly increased tool life in machining hard-to-cut metals, according to an announcement by D. W. Kaufmann, Product Manager of Tool Steels.

Mr. Kaufmann declared, "This steel is undergoing exhaustive evaluation in production use to confirm the preliminary laboratory and field tests. This new high speed steel promises to be the outstanding composition for tools designed to cut such materials as highly alloyed steels at high hardness levels, stainless steels, super alloys and titanium. Rex 49, with a base price of $2.07 per pound, is outperforming the more expensive high cobalt and high vanadium high speed steels. It is expected to eliminate the need for many of the more than 20 special-purpose grades now in use."

"The steel can be heat treated to

Rockwell 'C' 67 to 69. In tests so far on many hard-to-machine metals, it has outperformed other high speed steels, increasing tool life 2 to 4 times. In the cutting of more normal materials, its use permits increases in speed, feed or depth of cut."

Rex 49 is the latest in a long series of technical developments in high speed steels at Crucible, starting with Rex AA, the original 18-4-1 high speed steel, in 1904.

Semi-Commercial Production of Fluorine-Containing Thermoplastic

➤ PENNSALT Chemicals Corporation has initiated semi-commercial production and marketing of KYNAR, its new vinylidene fluoride resin. Kynar, heretofore designated as RC-2525 Resin, is a totally new fluorine-containing thermoplastic resin designed for long life and high performance in environments which degrade less stable materials. First of an expected series of products from Pennsalt's polymer research program, Kynar is now available as molding powder and pelletized resin for end item development and use.

Chemically, Kynar is a crystalline,, high molecular weight polymer of vinylidene fluoride, $(CH_2\text{-}CF_2)n$, containing over 59% fluorine by weight. Its properties are strongly influenced by the stability and inertness characteristic of highly fluorinated molecules. Data obtained from standard laboratory tests and functional evaluations of fabricated parts show Kynar to be mechanically strong and tough, resistant to distortion and creep at low and high temperatures, highly resistant to the attack of corrosive chemicals, flame resistant, and to be stable under extreme conditions of weather and ultraviolet radiation.

In addition to molding powder and pelletized resin, Pennsalt plans to introduce Kynar in the forms of organosols and solutions in high boiling organic solvents. These forms will be field tested for several months before being offered commercially. With the advent of resin availability, Kynar will soon be supplied in the form of rod, tube, and sheet by a number of plastic fabricators. These standard shapes can be readily cut, machined, sealed, welded and formed into almost any design without lowering the resin's high level of mechanical strength and stability. Being truly thermoplastic, unused portions from die cut stock can be re-used for molding and extrusion.

Because of Kynar's resistance to the attack and penetration of highly corrosive chemicals, it should find numerous packaging applications such as drum and container coatings; sealed pouches for chemicals, lubricants and propellants; and sterile packages for food, pharmaceuticals, and medical instruments.

The combination of Kynar's high mechanical strength, toughness, and stability to extreme environmental stresses provides a capability for high performance in applications ranging from equipment for drilling or mining below the earth's crust to components used in space flight.

Of primary interest to electrical equipment designers is the use of thin wall jackets for wire and cable where Kynar's toughness, high surface resistivity, weatherability, and flame resistance are significant properties. In addition, thin wall tubing can be used as sleeving for wire and cable

terminals, and as protective coatings over various electrical components such as resistors.

Product information, price schedules, samples and technical service on Kynar may be obtained by writing to Pennsalt Chemicals Corporation, Research Products Development Department, P.O. Box 4388, Philadelphia 18, Pa.

New High Solids Vinyl For Spray Equipment

➤ A NEW HIGH build vinyl coating, Amercoat No. 99, has been developed for application with either conventional or airless spray equipment. The new coating is not a mastic, yet it overcomes the application disadvantages of most vinyls, which require multiple coats to achieve minimum protective thickness. As a result, substantial savings are being obtained on material and labor required to provide lasting protection against industrial, chemical, petroleum and marine corrosion.

Amercoat No. 99 retains the superior chemical, weathering and physical properties of Amercoat No. 33, which has been widely used for corrosion control since 1943.

When applied with airless spray equipment, only one cross sprayed coat of No. 99 is required to obtain a dry film thickness of more than 5 mils. Using conventional spray equipment, only two coats are required to produce a dry film thickness of 5 mils. Handling characteristics are excellent; the coating barely sags even with a wet film thickness of 25 mils.

Thoroughly proved through long and severe field tests, No. 99 is recommended for use on tank exteriors, ships' hulls and all types of structural steel. It may be applied over organic primers; when teamed with one coat of an inorganic zinc silicate coating such as Dimetcote, it is unequalled by any other known coating system for purposes which it is intended.

No. 99 dries to a hard and tough matte finish which adheres firmly and resists abrasion. Non-flammable, odorless and non-toxic, it will not harbor bacteria or fungi. Descriptive Bulletin No. 99 may be obtained from Amercoat Corporation, South Gate, California.

Flame Retardants

➤ SIX NEW chemical compounds which may prove to be the first practical and economical means of giving flame-retardance to a wide variety of plastics, synthetic fibers, rayon and wood products have been discovered by Monsanto Chemical Company.

The new compounds, identified as organopolyphosphorus esters, are derived from a new general chemical reaction discovered recently by Dr. Gail H. Birum of Dayton, Ohio, a scientist in the chemical research department of Monsanto's Research and Engineering Division. He disclosed his finding at the American Chemical Society's 138th national meeting.

Commercial introduction of the six new flame retardants obtained via the Birum reaction was announced at the same time by the company's Organic Chemicals Division. They are being offered in evaluation quantities under the trademark "Phosgard."

A cheap and efficient means of imparting flame retardance to such polymers as polystyrene, polyesters, phenolics, acrylics, epoxies, polyurethanes and polyolefins has been a major target of chemical research in recent

years, spurred by the rapidly expanding use of these plastics in building and other structural applications.

H. David Cummings of St. Louis, project manager of resin materials development for Monsanto's Organic Chemicals Division, estimates that close to 400 million pounds of these polymers annually find uses in which flame retardance would be a significant advantage if obtainable at low cost and without sacrifice of other properties. To date, no flame retardant additives have met these dual requirements, Cummings added.

The six "Phosgard" flame retardant compounds are the first of what may be "quite a number" of potentially useful new chemical compositions to derive eventually from the Birum reaction, according to Monsanto.

By permitting the combination of relatively simple, inexpensive and readily available chemical raw materials in a heretofore unknown manner, the reaction is capable of yielding a broad class of new phosphorus, chlorine and/or bromine-containing end products.

Molybdenum Gives Clue

➤ A METAL dissolved in streams in such small quantities it can scarcely be detected may lead prospectors to rich ore deposits.

Using a new method devised by U. S. Geological Survey scientists, less than one part per billion of this metal, molybdenum, in water can be detected. Molybdenum, a silvery white element similar to iron, is an important indicator of ore deposits because it is generally found with ores whose metals are needed for industrial purposes.

The metal is dissolved in water when streams flow through an area containing the ore deposits.

Streams are tested for traces of molybdenum by taking a water sample and passing it through a resin that traps the minute particles of metal. The resin is leached by an acid and, if the metal is present, the acid solution turns amber.

Drugs Open Air Passages; Heart Vessels

➤ A NEW series of chemicals that dilate the air passages of the lungs and the blood vessels of the heart has been developed.

The chemicals, some of which probably will be developed as prescription drugs, are the 1, 3-dialkyl-6-thioxanthines. They differ from a well-known dilator drug, theophylline, in that a sulfur atom has been substituted for an oxygen atom in the chemical structure.

Some of the new 6-thioxanthines are 60 times as active as the corresponding salts of the older drug, theophylline, in test-tube tests. In the living animals, the effectiveness of the chemicals is reduced, but they are still potent enough to protect guinea pigs from the deadly effects of an aerosol spray that narrows the air passages.

The research was reported in the British scientific journal Nature by Drs. A. K. Armitage and K. R. H. Wooldridge of May and Baker, Ltd., Dagenham, Essex.

Mineral Discoveries in China

➤ RECENT valuable mineral discoveries in Red China are due to the vast increase in the number of her trained scientists since the Communist regime came to power, Dr. Edward C. T. Chao of the U. S. Geological Survey in Washington, D.C., said in New York City.

Prior to 1950, before the Communists assumed control over China, only about 200 scientists were actively engaged in geological research. Now Red China boasts over 21,000 "geological workers," he reported at the 127th annual meeting of the American Association for the Advancement of Science.

Among the many new and large mineral deposits discovered by this corps of Chinese geological workers is the molybdenum reserve, now rated "number one in the world."

Molybdenum is one of the important hard, light, temperature-resistant metals particularly useful in the construction of airplanes and space vehicles.

"The Chinese geologists also have discovered very large iron and copper deposits that from reports would appear to compare with any of the world's first rate deposits of these valuable metals, Dr. Chao told Science Service. New deposits of boron, potash and chromium also have resulted from surveys made by the "geological workers," as well as important sources of radioactive minerals.

The production of tungsten, tin and antimony, for which China has been world famous for nearly half a century, also has shown a marked increase under the Chinese Communists. In recent years, Communist China had been the foremost world producer of tungsten and antimony, world-significant export metals; and she is now the second ranking producer of tin.

This progress, Dr. Chao pointed out, is being made by a country whose geological research is still virtually in its infancy.

He underscored the strong Russian influence that "permeates some areas of thinking in Chinese geology." Many field and laboratory procedures are patterned after the Russians, Dr. Chao said. More than 400 Russian geologists and engineers have visited China and participated in field geologic work or training program in China, in the past ten years.

"The western geologist may do well to anticipate that, in the next generation, a vast amount of significant geologic information will be forthcoming in both the Chinese and Russian languages; information that covers in addition to some 8.5 million square miles of Russian territory, some 3.5 million square miles of China," Dr. Chao said. "Their geologic explorations are keyed to their long-range plans for industrialization and this tremendous boost in scientific achievements will add tremendously to the wealth and industrial power and development of Communist China."

Union Carbide

This is the fifth of a series of eight articles to be presented in CHEMISTRY this year. Many of the students now preparing for a career in chemistry will eventually join one or other of the large corporations and this series, featuring eight of the major companies employing chemists in the United States, is intended as a preview into the type work that they will be doing.

➤ PERHAPS MORE than any other major American chemical company, Union Carbide Chemicals Company is a true "child of research." The company was born of research, was nurtured by research, and has grown and prospered through research. Traditionally, the primary goal of Union Carbide Chemicals has been to develop new chemicals for markets — not just to produce established chemicals by established processes to compete with established producers in established markets.

The story of Union Carbide Chemicals Company started on November 15, 1914, at the Mellon Institute in Pittsburgh. An "Illumination Fellowship" was founded by the Prest-O-Lite Company, later to become part of the Union Carbide family, to seek a way to produce acetylene from sources other than calcium carbide. Dr. George O. Curme, Jr. was charged to carry out this investigation. On July 1, 1915, Union Carbide Company also, research-minded, established an "Organic Synthesis Fellowship" at Mellon Institute to seek new ways to utilize acetylene or calcium carbide. This research group included Dr. Harold Hibbert, Dr. H. A. Morton, and Mr. H. J. Little. In 1917, when the two companies merged, the two programs were brought together. The scope of the quest broadened to consider not only acetylene, but other natural and petroleum gases as versatile sources of hydrocarbon raw materials.

By 1920, potential new products and production techniques had poured out of the consolidated program by the dozens, yielding such commercially unheard-of chemicals as ethylene oxide and isopropyl alcohol. An exciting new vista had opened up — synthetic aliphatic chemistry based on petroleum raw materials. This became the foundation of today's vast petrochemicals industry.

Petroleum, thanks to the work by Dr. Curme, was found to be a prime source for some very interesting and reactive raw materials: ethylene, propylene, and butylene. He also found that these reactive raw materials could serve as a basis for the synthesis of an almost unlimited number of new and promising industrial chemicals.

On the strength of these findings, Union Carbide Chemicals Company (then called Carbide and Carbon

➤ SEVEN BUILDINGS *compose the Research Department area of Union Carbide's Technical Center at South Charleston. Most of the Research Department buildings were completed in 1949, and were the first buildings on the site.*

Chemicals Corporation) was formed in 1920. The company's first production facilities consisted of a small plant at Clendenin, West Virginia, that was stripping gasoline from natural gas.

From the very beginning of its corporate life, this new chemical company was a pioneer. Early work was largely experimental, attempting to take research results and adapt them to commercial production. Pyrolytic cracking and rectification techniques were developed first to convert the rich supply of ethane and propane into the olefins, ethylene and propylene.

By 1933, the list of chemicals had increased to five-dozen distinct chemical compounds. In recognition of the company's ". . . meritorious contribution to the advance of the industry and profession . . ." they were awarded *Chemical and Metallurgical Engineering's* "Chemical Achievement Award" in 1933 — the first time that this award had been given to a company instead of an individual.

➤ Analyses of *compositions and the determination of properties are an essential part of new product development and customer service at Union Carbide Chemicals Company's new Technical Service Laboratory located near Tarrytown, New York, in Westchester County.*

For its efforts during World War II the company received two additional awards for chemical achievement for work on synthetic rubber and atomic energy. In the years after World War II, research yielded many new products, and in 1953 Carbide was again the recipient of the "Chemical Achievement Award." Today, Union Carbide's product line includes over 400 synthetic aliphatic chemicals, of which about 150 are produced in tank-car quantities. And over the years Union Carbide has been introducing new chemicals at an average rate of two a month. Almost as many older ones graduate to the commercial tank-car category each month.

One of the earliest contributions of Union Carbide Chemicals Company was a process to synthesize acetone from hydrocarbon raw materials. However, acetone produced by fermentation was subjected to undesirable price and supply changes; and because of the important role that this product had in a captive use, Carbide decided to manufacture its own acetone through a synthetic route.

Carbide was the first to use by-product furnace gas (essentially pure carbon monoxide) with hydrogen

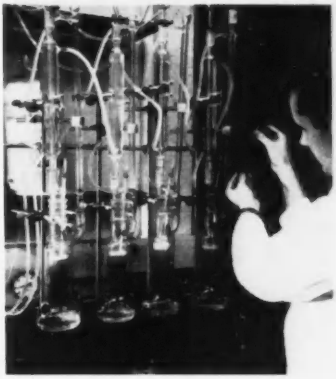
(from steam) and catalysts to make synthetic methanol. This also yielded a product of higher purity and more stable price and supply than was possible for methanol derived from wood distillation.

Synthetic ethanol is one of the most often noted early developments by Carbide. The reaction of ethylene with sulfuric acid and water was a laboratory experiment known 102 years before Carbide came along to make the reaction industrially practicable. Others had tried and failed, but to Carbide scientists it was a logical use for the large quantities of ethylene that could be made at relatively low cost by hydrocarbon cracking. The company became a pioneer producer of synthetic ethanol.

Vinyl resin production was another early interest at the South Charleston plant. Among the most glamorous of the company's early discoveries, it started as a search for synthetic tung oil during the 1920's. The researchers failed in their quest for a tung oil replacement but came up with vinyl chloride, which, when combined with vinyl acetate, started a whole new industry based on these types of polymers.

Back of this record of invention and innovation lies an unusually strict adherence over the years to certain basic tenets. Carbide's main distinction is that it has kept strictly within its process orbit. The company has been primarily a developer and producer of raw materials and intermediates for industry. It uses its special combination of research, development, and engineering skills to extend these chemical frontiers.

And Carbide has never skimped on research. The company's philosophy is to start with known raw materials and work toward an unknown end product. But its research is not limited to seeking entirely new concepts or products. A great portion of the company's profits come from the wholly new products added from research. The remainder comes from maintaining a strong position in unpatentable fields (or in fields where patents have long since expired on basic processes) by combining research and technology to create processes and products that are better or more economical.



➤ A NEW *Ucon fluid is being tested to determine its effect on various metals. This part of the Carbide program is designed to provide the automotive industry with a functional fluid satisfactory for central hydraulic systems for tomorrow's cars—a single fluid to actuate brakes, power steering, power brakes, and automatic transmissions, and to lubricate differentials.*

Carbide supports its research effort by maintaining several major research and development laboratories supplemented by research at independent organizations and universities. One sign in evaluating the depth of this dedication to research can be found in the company's research expenditures which have been counted in millions of dollars for a number of years.

Paramount in the company's research program is the Technical Center at South Charleston, West Virginia. This group of buildings is a self-contained science city conducting experimental and engineering activities for Union Carbide Chemicals Company, Union Carbide Olefins Company, and Union Carbide Plastics Company. The products that come into being at the Technical Center are produced at Carbide's manufacturing plants throughout the United States as well as abroad.

There are more than a thousand scientists and engineers in the Technical Center. They are supported by the most modern specialized equipment, including infra-red spectrophotometers, mass spectrometers, chromatographic analyzers, electron microscopes, X-ray diffraction equipment, electronic computers, and an irradiation laboratory.

Technical Service

Another area of chemical industry research, essential in today's highly competitive marketing, is that which is called, variously, technical service, customer service, applications research, end-use research, applied research. Fulfilling this need is the new Technical Service Laboratory located at Tarrytown, New York. The laboratory accommodates about 100 scientists along with supporting personnel. It has facilities to solve scientific, formulation, production, and applications problems for Carbide customers in scores of industries.

The scientist in technical service has a key role in helping to translate basic science and technology into terms of useful consumer goods. His goal is to aid in expanding the uses of the company's product line. But technical service is, nevertheless, a creative endeavor. It differs from basic research mainly in that the researcher has a more clearly defined goal toward which he works, rather than the general search for "truth" regardless of commercial value. The basic researcher seeks a fact; the applied researcher seeks a use for that fact.

It is difficult, in a single article, to delve into all of the contributions of Carbide researchers. In all, the company is involved in the production of industrial chemicals (such as ethylene oxide, butanol, and acetic anhydride); a myriad of other chemicals called "new chemicals" and including intermediates for pharmaceuticals, dye intermediates, stabilizers, and special plasticizers; agricultural chemicals including Sevin insecticide; resins, including over 23 basic types of vinyl resins as well as large quantities of polyethylene; and textile fibers (Dynel) — a modacrylic staple fiber.

Newer Products

Among the newer products, born of research within the company, are Polyox water-soluble resins, homopolymers of ethylene oxide that can be made in molecular weights ranging from fifty thousand to several mil-

lion. One form of this interesting new material, a water-soluble film, holds great promise for the packaging of household specialties as well as for formulation into soaps, latex paints, cosmetics, and pharmaceuticals.

Another interesting development by the Carbide Research Department is the development of entirely new types of epoxy compounds. The key to this development was a research program culminating in a new way to make high-purity peracetic acid for use as a chemical intermediate. The peracetic acid is used to epoxidize unsaturated organics (place an oxygen across two carbons having a double bond) that are not readily susceptible to other epoxidation reactants. Eight epoxy compounds, from the several hundred synthesized in the laboratory to date, have been selected for commercialization.

For some time now Carbide has been interested in rocket fuels. The Technical Center scientists are investigating both liquid and solid propellents. Back of this interest is the fact that some of the most attractive possibilities for rocket fuels are based on materials produced by Union Carbide.

Other research projects underway currently include the study of new plasticizers, new brake fluid and antifreeze formulations, safe and more effective food additives, corrosion inhibitors, new pesticides, surface coatings, monomers and polymers, and urethane foam intermediates.

Though no one can predict specific developments to come in the future, the success stemming from the combined efforts of basic and applied research during the past decade give an idea of the improvements which spring from such efforts; crease-resistant cottons, wash-and-wear fabrics, improved all-winter automotive antifreezes, heavy duty brake fluids, liquid household detergents, textile softeners, dry-bright floor waxes and finishes, home permanent wave lotions, aerosol packaging, polyether foam cushioning, water-thinned latex paints, and many others.

People in the United States tend to assume that our store of raw materials will remain abundant forever. But as our population and standard of living continue to rise, a heavy drain is placed on our natural resources. The chemical industry expands these resources by creating useful products from previously wasted, or unused, raw materials. This is possible only through progressive and continuing research.

Compounds of "Dinosaur"

➤ The first pure compounds of the man-made element californium, no. 98, have been prepared by scientists at the Lawrence Radiation Laboratory of the University of California, Berkeley, where this element was first made.

Preparation and identification of the compounds was carried out by Drs. Burris B. Cunningham and James C. Wallmann. Three separate californium compounds — californium trichloride, californium oxychloride and californium oxide — were

prepared by treatment of the element with hydrochloric acid and steam at high temperatures.

Dr. Glenn T. Seaborg, Nobel Prize-winning chancellor of the University of California at Berkeley, described the work in a distinguished lecturer's address at the winter meeting of the American Nuclear Society.

Dr. Seaborg said the feat of carrying out identifiable chemical reactions with such minute quantities of materials — samples weighing about a ten-millionth of a gram — was accomplished as a result of the recent perfection, by Dr. Cunningham and his colleagues, of techniques for working on the "submicrogram" scale.

Californium is one of the "dinosaurs" of matter — an element that may have been present in the beginnings of the earth but soon disappeared through radioactive decay. The element was first fabricated with the use of the atom smashers by University of California scientists.

Dr. Seaborg also stated that a neutron irradiation program now in progress at the Materials Testing Reactor at Arco, Idaho, will yield about a ten-millionth of a gram of einsteinum (element 99) early next year. This quantity, he said, might be enough to permit the isolation of einsteinum for the first time.

Einsteinium is likely to be the only remaining transuranium element that can be isolated in visible amounts, because of the increasingly short lifetimes of the heaviest synthetic elements. Visible quantities of berkelium and californium (elements 97 and 98) were first isolated two years ago by Dr. Cunningham and Dr. Stanley G. Thompson at the Lawrence Radiation Laboratory.

Although elements beyond the presently known 102 will undoubtedly be discovered, Dr. Seaborg said, it should be possible to produce and detect not more than an additional half dozen or so.

The best chance of success, he said, lies in the firing of heavy ions into targets of high atomic number. The small number of atoms of new elements produced, coupled with their extremely rapid decay, will soon require development of new methods of identification.

Dr. Seaborg predicted that the longest-lived isotope of element 104, for example, will have a half-life of only a few minutes or less. With element 106, this will be reduced to but a few seconds or less, and no isotope of element 108 is likely to have a half-life of more than a tenth of a second.

Dr. Seaborg also described the current research efforts of Dr. Albert Ghiorso and his co-workers to discover element 103 in the heavy ion linear accelerator at the Lawrence Radiation Laboratory.

The researchers are attempting to create an isotope of element 103 with atomic weight 259 by bombarding californium-252 with boron-11 nuclei. This particular isotope of element 103 is expected to have a half-life in the range of a fraction of a second up to a minute or two.

Methods of detection and separation being used are similar to those used in the discovery of element 102 in 1958. If this isotope of element 103 can be produced, it can be identified through its decay product mendelevium-255, which has a half-life of about 30 minutes.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupon (but not stamps) for each patent ordered.

New Candle Drips With Color

➤ CANDLES made with tightly braided wicks burn so slowly that the melted wax is pulled up into the wick as fast as it melts. Consequently these candles do not drip.

Mr. Walter Weglin has invented a candle that not only drips but it drips in color. He has been awarded patent No. 2,959,950 for this invention. His candle is constructed with a porous wick that does not absorb the wax as fast as it melts. His candle also is constructed with a plurality of horizontal colored rings so that the candle drips with color.

Production of Sugar From Wood

➤ WOOD and other cellulosic materials can be converted into sugars by hydrolysis in the presence of an acid. The common method has been with an aqueous solution of acid at temperatures above the boiling point of water.

Two Swiss chemists have devised a process for hydrolyzing these materials using an alcoholic solution of acid. Mr. Paul Schlapfer of Zurich and Mr. Henri Casimir Silberman have been awarded patent No. 2,959,500 for their invention. This method causes the lignin produced as a by-product to be dissolved in the resulting solution while the older methods caused lignin to precipitate.

Fermentation Process For Beta-Carotene

➤ BETA-CAROTENE is a precursor of Vitamin A. It occurs naturally in yellow vegetables such as the carrot. It is also synthesized by certain microorganisms.

A new process has been developed for preparing beta-carotene by the cultivation of a microorganism of the genus Choanephora in a nutrient medium containing a terpenoid substance and an ionone. This process was developed by Mr. James E. Zajic of Muscatine, Iowa. He has been awarded U. S. Patent No. 2,959,522 for this discovery.

The patent has been assigned to the Grain Processing Corporation of Muscatine, Iowa.

Rust Preventive And Lubricant

➤ A WATER-BASE rust preventive has been discovered that has excellent lubricant properties. The rust preventive consists of water mixed with sodium and barium soaps of oxidized petrolatum, an alkyl phosphate and an oil.

U. S. Patent No. 2,959,549 has been awarded to Mr. Michael J. Furey of Berkeley Heights, New Jersey for this discovery. He has assigned the patent to the Esso Research and Engineering Company of Delaware.

√ *Chemistry Quiz* √

Directions: Mark the answer you think *most nearly correct.*
Answers are on page 39.

A. The atomic weight of an element is
1. the actual weight of a single atom.
2. the number of protons in the nucleus of the atom.
3. the number of neutrons in the nucleus of the atom.
4. the number of electrons in the atom.
5. the relative weight of a single atom.

B. The most prevalent metal in the earth's crust is
1. iron.
2. silicon.
3. calcium.
4. aluminum.
5. sodium.

C. Hydrogen is prepared by the
1. decomposition of helium.
2. reaction of steam with coal.
3. decomposition of carbon dioxide with steam.
4. reaction of nitric acid with copper.
5. liquefaction of air.

D. A concentrated solution is a solution that
1. contains more solute than solvent.
2. is saturated.
3. contains a high percentage of solute.
4. has been cooled.
5. contains equal amounts of solute and solvent.

E. A strong electrolyte is a compound that when dissolved in water
1. is 100 per cent ionized.
2. requires a high voltage to conduct an electric current.
3. can not be decomposed by electrolysis.
4. will not react with other compounds.
5. decomposes violently.

U.S. Scientists Average $9,000

➤ The average U. S. scientist is a $9,000 a year man.

Data for 1960 gathered by the National Science Foundation show that half of 110,000 scientists responding to a questionnaire earned more than $9,000 and half earned less.

Comparable statistics for 1959 showed, in addition to salary, $1,000 more, probably from consulting fees, royalties and other income.

The median age of this full-time employed group was 38 years. The work reported was 38% in research, development and design, 27% in management and administration, and 15% in teaching.

For the Home Lab

Cosmetics

by Burton L. Hawk

➤ The cosmetics industry is a fabulous one; versatile and volatile. Perhaps no other industry is so dependent upon the whimsy of one segment of the population: the American women. And, if you know women (who does?), you will agree that they can be whimsical. Thousands of dollars are spent to develop a product which may be entirely rejected by the women; or, it may become exceedingly popular. Thus fortunes can be made or lost overnight.

Although there are "standard" formulas for the preparation of the common cosmetics, each manufacturer has his certain "secret" formula which may contain several added ingredients designed to impart a specific property to his product. As you can imagine, these formulas are carefully guarded secrets.

The common cosmetics are very easily made in the home laboratory. The ingredients are relatively inexpensive although some of them may be somewhat difficult for you to obtain. Stearic acid is a popular ingredient for many cosmetics. The U.S.P. variety, consisting of a mixture of stearic and palmitic acids, is the type used. Commercially, it is known as "triple-pressed" stearic acid. A chemical supply house should be able to furnish this and most of the other ingredients.

Vanishing Cream

First, 6 grams of stearic acid are melted over a water bath. Place the material in a glass evaporating dish or beaker, and immerse in a shallow container of hot water. Apply heat so that the water boils moderately. The stearic acid will melt to a clear colorless liquid at about 55 deg. C. In another container dissolve 0.2 gram of sodium hydroxide in 30 cc. of water. Add this solution to the melted stearic acid, in small quantities, with continual stirring. Constant and thorough agitation is necessary to produce a smooth cream. Continue heating and stirring for a few minutes. Then remove from the water bath, add 4 cc. of glycerine and stir until the mixture is cold. This is a "typical" vanishing cream, unperfumed of course. If you want to add perfume, add it with the glycerine. The type and quantity of perfume is matter of personal taste. This matter alone requires considerable research on the part of the manufacturer, because he realizes that often the particular odor of his product will determine whether or not it will sell.

Through the years, formulas have been improved. We now will prepare a "deluxe" vanishing cream which contains many different products all designed to produce a smoother cream with better lubricating properties. Mix together 6 grams of stearic acid with 3 grams of diglycol stearate and melt over a water bath. Dissolve 0.5 cc. of triethanolamine in 38 cc. of water and add to the melted stearic

acid mixture with continual stirring. Remove from the flame and add 1 cc. of glycerine and 1 cc. of isopropyl myristate. Stir until cold. Compare this cream with that prepared above. Which do you prefer?

Cold Cream

A simple cold cream can be made by melting together over a water bath 3 grams of lanolin, 10 grams of white petrolatum ("Vaseline"), and 1 gram of paraffin wax. Stir until the ingredients are well blended. In another container dissolve 1 gram of borax in 5 cc. of water. Add this to the molten mixture, stirring rapidly. Allow to cool. This forms a soft smooth cream.

Modern cold creams are composed mainly of beeswax and paraffin oil. Warm on a water bath 30 cc. of paraffin oil. Add to this 9 grams of white beeswax. Stir until the wax is entirely dissolved. In another container dissolve 0.5 gram of borax in 10 cc. of warm rosewater. Add this to the melted wax, stirring until a smooth consistency is obtained. Allow to cool.

For the "deluxe" variety, dissolve 8 grams of beeswax in 25 cc. of warm paraffin oil, as above. In another container dissolve 0.5 cc. of triethanolamine in 16 cc. of water and add to the liquid wax, stirring briskly. Remove from the heat, add 2 cc. of isopropyl myristate and continue stirring until cold. Compare the three cold creams and decide which you like the most.

Brushless Shaving Cream

Of course, not all cosmetics are for the ladies! This time, melt on the water bath a mixture of 14 grams stearic acid, 3.5 grams of propylene glycol monostearate, 1 gram of anhydrous lanolin and 2 cc. of paraffin oil. To the melted mixture, add a solution of 1 cc. of triethanolamine dissolved in 76 cc. of water, stirring continually. After the ingredients are thoroughly blended, add 1 cc. of isopropyl palmitate and 2 cc. of glycerine. Continue stirring until cool.

Hair Oil

Mix together 10 cc. of isopropyl palmitate, 25 cc. of castor oil, 15 cc. of olive oil, and 56 cc. of mineral oil.

Lipstick

Using the water bath, melt together 20 grams of glyceryl monostearate, 2 grams of carnauba wax, and 2 grams of "Vaseline." To the melted mixture, stir in 18 cc. of castor oil followed by 5 cc. of isopropyl myristate. Of course with lipstick color must be added as well as perfume. To the above mixture is added 1 gram of eosin color acid and 2.5 grams of color lakes.

Greaseless Cream

If the above creams are too greasy for you, here is a simple non-greasy preparation. Place in the usual water bath 25 grams stearic acid, 2.5 grams sodium carbonate, 1.25 grams borax, 40 cc. glycerine and 142 cc. water. Heat the mixture for about one half hour until thoroughly blended. Then add 7 grams of lanolin. Stir thoroughly and cool.

Cleansing Liquid

Dissolve 1 gram of soap in 100 cc. of water.

For a change, we need not issue the usual warning about being careful not to spill the materials on your skin. In this case, all of the above

preparations are beneficial to the skin and you may use them without fear.

It looks as though cosmetics are here to stay. Once considered a luxury, they are now thought of as a necessity. It has been said (not by me!) that women will stop buying food before they stop buying cosmetics.

So be it!

Chemistry Teacher Awards

➤ ESTABLISHMENT of the 1961 College Chemistry Teacher Awards program, honoring six outstanding college teachers throughout the United States, has been announced by the Manufacturing Chemists' Association.

This is the fifth consecutive year in which the national chemical industry trade association has made these awards. Purpose of the awards is to honor the men and women engaged in college science teaching, call public attention to the importance of good science teaching at the undergraduate level, and inspire qualified students to choose careers in science teaching.

The six medals and citations to be presented at the Association's Annual Meeting June 8, 1961 at White Sulphur Springs, W. Va., will be accompanied by awards of $1,000 each. Two awards will be granted in each of the three regions into which the country has been divided in order to provide approximately the same number of accredited schools in each region.

Region 1 is composed of the New England states, New York, Pennsylvania, Ohio, Delaware, New Jersey and Michigan. Region 2 is made up of Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Florida, Puerto Rico, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma and Texas. The remainder of the states comprise Region 3.

To be eligible for nomination for one of the awards a teacher must have had at least 10 years service in undergraduate teaching in chemistry, chemical engineering or other allied courses. The teacher must be nominated by the president of the college where he is teaching, providing it is an accredited college or university offering four-year bachelor degrees. However, there is no minimum length of service required at the institution from which he is nominated.

In reviewing a nomination the judges will consider convincing evidence that the nominee has been personally responsible over a period of years for awakening in students a genuine interest in chemistry, for inspiring them to serious intellectual effort in studying that field, and for developing that interest into a continuing dedication.

The six outstanding teachers to receive the 1960 MCA award were: John De Vries, Calvin College, Grand Rapids, Mich.; Reynold C. Fuson, University of Illinois, Urbana, Ill.; Ben Harrison Peterson, Coe College, Cedar Rapids, Iowa; Francis O. Rice, Georgetown University, Washington, D. C.; Walter Hugo Stockmayer, Massachusetts Institute of Technology, Cambridge, Mass.; and Moddie D. Taylor, Howard University, Washington, D. C.

AICE Meeting

Highlights from the December meeting of the American Institute of Chemical Engineers in Washington.

Valuable Natural Resource

➤ THE WORLD'S most important natural resource, water, sells for about ten cents a ton but nearly 100 billion dollars will have to be spent by the United States to meet the demand for it in the next 20 years.

Dr. A. L. Miller, director of the Interior Department's Office of Saline Water, said this about water at the American Institute of Chemical Engineers meeting.

He reported that his office has 54 different contracts with private industry, universities and technical institutions dealing with the problems encountered in the conversion of saline water to fresh water.

Forty million Americans are on the verge of a serious water shortage. The water supplies of 42% of the cities of the United States are considered inadequate. Yet the oceans have an unlimited supply of water estimated at 320 million cubic miles. Low-cost salt water conversion processes would provide an inexhaustible water supply.

Freezing Salt Water with Gas

➤ FRESH WATER for the exploding population of the earth can be produced from salt water by freezing with ordinary "cooking" gas at a cost of only 19 cents per 1,000 gallons for the power and chemicals.

George Karnofsky of the Blaw-Knox Company, Pittsburgh, Pa., reported these figures at a symposium on saline water conversion at the American Institute of Chemical Engineers meeting.

Butane is used as a refrigerant and as a melting agent in the process. A pilot plant for further studies is now being built. Preliminary studies indicate that a plant with a ten-million-gallon per day capacity can be built for $20,000,000.

The salt water is frozen and melted with normal butane or isobutane in a closed cycle, providing direct contact between the butane and the water in both freezing and melting steps.

Vapor Reheat Removes Salt

➤ A NEW PROCESS for the conversion of salt water to fresh water using the vapor reheat principle was described by D. F. Othmer, R. F. Benenati and G. C. Goulandris of the Polytechnic Institute, Brooklyn, N. Y., to the American Institute of Chemical Engineers meeting. The heat given off during the condensation of the evaporated water is used to heat the various stages as the pressure is progressively lowered. This lowers the energy and equipment requirements for the flash evaporation of sea water.

Fuel Cell Research Pushed

➤ INTEREST in use of fuel costs has reached a new high with more than 50 laboratories doing work on the problem, Sidney J. Magram of the Army Research Office, Washington, predicted at the American Institute of Chemical Engineers meeting. Fuel cells convert chemical energy into electrical energy as the fuel is burned in contact with the electrodes, which are separated by a suitable electrolyte. Hydrogen is the best fuel and either oxygen or air can be used as the oxidizing agent.

Nuclear Reactors for Plant Use

➤ NUCLEAR reactors involving dangerously radioactive fuels can be safely operated with standard equipment normally used in the petroleum industry, a three-year test has shown. The Organic Moderated Reactor Experiment, or O.M.R.E., N. J. Swanson, Atomics International, Idaho Falls, Idaho, reported to the American Institute of Chemical Engineers in Washington, showed that it is now feasible to operate organic-moderated and cooled power reactors with standard materials of construction and equipment commonplace to the petroleum industries. The maintenance of equipment requires only the use of conventional tools and mechanics of normal skills and abilities.

√ Answers to CHEMISTRY QUIZ on page 34.
A - 5; B - 4; C - 2; D - 3; E - 1. √

Science Talent Search
Project Report

The Inversion of Sucrose

by IRVING J. SPITZBERG
Hall High School, Little Rock, Arkansas

Irving J. Spitzberg, 17, was a winner in the 19th Science Talent Search. He hopes to major in chemistry at university with a view to becoming a research chemist.

➤ WHEN SUCROSE is dissolved in water with an acid the following reaction takes place.

$$C_{12}H_{22}O_{11} + H_2O + H^+ \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6 + H^+$$

This reaction is known as the "inversion of sucrose." It is a classical study in chemical kinetics. There have been over 1000 papers written on this reaction in *water*.

A study of kinetics is an investigation in reactions, rates and mechanisms. To complete a kinetic dossier of a reaction there are many fundamental elements to be considered. In this discussion only two such elements are investigated — the rate; the speed with which a reaction proceeds to equilibrium; and the order: the mathematical power to which the concentration of a substance is raised in a rate equation, representative of the collision and chemical activity of the substance.

It was noted by this experimenter that the "inversion of sucrose" reaction had, according to available data, been pursued only in a water solution. Due to the previous restricted pursuit, this investigation was launched to define the effect of water-alcohol solutions on the order of reaction and the specific velocity constant of the sucrose and acid reactants.

The data for this experiment was obtained through polarimetric analysis. This was possible because of the unique optical qualities of this reaction and the kinetic relationship between concentration of solute and rate and order.

General Procedure

Solutions were prepared containing 0% alcohol, 25% alcohol, 50% alcohol, and 75% alcohol mixed with water. Out of each of these solutions five combinations were made, three where the 3.1 normal hydrochloric acid was held constant, and three where the sucrose solution was held constant.

The different solutions were allowed to come to temperature equilibrium in a $20 \pm .2$ degree C water bath and then were analyzed in an O.C. Rudo polarimeter at intervals that were very carefully timed. Standard polarimetric technique was adopted. The polarimeter was carefully zeroed and each sample was analyzed three times using a ten millimeter polarimeter tube. The final result being an average of the three readings. Data were obtained from solutions of 0% alcohol to 75% alcohol. Above the 75% alcohol content it was found difficult to dissolve adequate amounts of sucrose.

➤ Irving J. Spitzberg, Jr., *with his science display, takes part in an exhibit held in Washington as a feature of the nineteenth annual Science Talent Institute. Irving is one of the 40 Science Talent Search winners who were chosen from over 29,000 high school seniors throughout the country.*

Sucrose Specific Rotation In Experimental Solutions

As will be explained later it was necessary to find the specific rotation of the sucrose in the various alcohol-water solutions. The data for this determination were found by preparing solutions of varying sucrose concentration in the various alcohol water combinations, and taking initial timed readings of each sample. The sucrose used in this procedure was especially dried in a suitable oven at 110 degrees C.

Basic Equation

The basic equation on which this treatment is built is the general rate equation:

$$(A) \qquad R = \frac{\Delta C_s}{\Delta t} = K\, C_s^{\,n}\, C_{H^+}^{\,m}\, \underbrace{C_{H_2O}^{\,p}}_{\text{Constant}}\, C_{EtOH}^{\,q}$$

R = Rate
C_s = Concentration of sucrose
t = Time

K = Specific velocity constant
C_H = Concentration of HCl
n, m, p, q = Orders of reactants

The first object of this investigation was to find the order of the sucrose reactant. This information was compiled by finding the concentration of sucrose through this equation:

$$(B) \qquad C_s = \frac{a}{\alpha_o\ \alpha\infty}\,(\alpha_m - \alpha\infty)$$

$$d = \frac{100\alpha_m}{l\ \alpha sp}$$

α_o = O time polarimeter reading $\alpha_m = C_s$ original
$\alpha\infty$ = Final polarimeter reading l = tube length
α_{sp} = Specific rotation

The specific rotation used in this equation (B) was known for 0% alcohol but for the 25%, 50%, and 75% alcohol solutions it was necessary to experimentally derive this value. The following relationships were used:

$$(D) \qquad (1) \quad \alpha sp = \frac{100\alpha_m}{g}$$

$$(2) \quad g = \frac{\text{gram S} \cdot 100}{\text{gram solution}}$$

The concentration of sucrose was then plotted against time. Slope readings (rate-R) were then taken and the logarithms of these slopes were then plotted against the logarithm of C. This procedure is justified by the derived equation:

$$(C) \qquad \log R = n \log C_s \quad \text{Constant}$$

For the 25% and 50% alcohol solutions the α specific was plotted against sucrose concentration to find the desired values. For the 75% alcohol solution the experimental data was inconclusive; but the accurate sucrose concentration values (g) were recorded and substituted directly into the equation.

The slope of the graph is the order (n) of the sucrose reactant in the particular solvent.

Order of HCl

By general equation A, if the concentration of sucrose is kept constant, the order of HCl can be found by plotting the log slope (Y) against the log C_H and measuring the slope of this graph. This method proved unsatisfactory, so instead I substituted the equation:*

$$(E) \qquad \log t^{1}/_{2} = (1\text{-}n) \quad \log C_{HCl}$$

I found $t^{1}/_{2}$ by taking log C_s and plotting it against time. Then I plotted log $t^{1}/_{2}$ against log C_{HCl} and found the order from the slope.

* Physical Chemistry – E. A. Moelwyn – Hughes, Pergamon Press, N.W. Page 1090.

Specific Velocity Constant

The specific velocity constants were found by using another form of the basic equation: (A)

$$(F) \quad K = \frac{R}{HCl^n \; C_s{}^m}$$

This constant is expressed in minutes $^{-1}$ moles $^{-n}$ liters ^{n}.

Conclusion

1. The order of the sucrose reactant in the inversion process is *one* in all solutions. For this reason it must be concluded that alcohol has no effect on this reactant. This conclusion was drawn from log C_s, log R graphs for all lines were found to have a slope of one.

2. The order of the HCl reactant in the inversion process is *one* in the 0% alcohol solution. Yet the order changes to *two* in the 25%, 50%. and 75% alcohol solutions. This conclusion was drawn from the log C_{HCl} / log $t_{\frac{1}{2}}$ slope.

3. The specific velocity constant in the 0%, 25%, 50%, and 75% alcohol solutions tends to increase drastically.

Hypothetical Explanation of Results

The fact that the sucrose reaction maintains an order of one is evidence that the sucrose - HCl-H_2O reaction is proceeding unaffected materially by the addition of alcohol. That the order of the acid is changing to two, leads this experimenter to believe that in addition to the reaction

$$\text{Sucrose} + \text{Water} = \text{Fructose} + \text{Glucose}$$

that perhaps a new secondary reaction is taking place in the form:

$$\text{Sucrose} + E_tOH = \text{Glucose} + \text{Fructose} \cdot E_tOH$$

and/or

$$\text{Fructose} + \text{Glucose} \cdot E_tOH$$

Because of this additional reaction the HCl is required to assume the order of two.

Anti-Cancer Agent Inhibits Penicillin

► Nitrogen mustard, an anti-cancer agent, decreases the antibiotic activity of penicillin. This finding may be a clue to why cancer patients receiving antibiotics may suddenly become more susceptible to infection. The test-tube experiments, conducted by Drs. Stephan E. Ritzmann and William C. Levin at the University of Texas Medical Branch, also showed that nitrogen mustard did not alter the antibiotic activity of erythromycin or of chlortetracycline (aureomycin). The reason for the difference is not known, but one theory, suggested by the researchers in Texas Reports on Biology and Medicine, is that nitrogen mustard may interfere with the carboxyl group of penicillin, a group not present in the other two antibiotics.

Ten Top Science Advances

➤ THE TEN TOP science advances in 1960 as selected by Dr. Watson Davis, director of Science Service, are:

1. Repeated successful launchings of U. S. satellites that view the earth for weather and other information, repeat radio messages and perform other functions, together with safely bringing back to earth satellite capsules designed for carrying human space travelers.

2. Photography with 200-inch telescope of galaxies (like our Milky Way) six billion light years away.

3. The hybridizing of turkey and chicken, first cross between two families of birds.

4. Discovery of chemical predecessors of living matter in stony meteorites from outer space, indicating life could exist elsewhere in the universe.

5. Approval for use of the Sabin live oral vaccine for polio.

6. The high altitude Project Excelsior balloon flight and parachute jump which set new world records, and demonstrated man's capacity to withstand exposure to conditions of outer space.

7. Brain waves picked up from single nerve cells.

8. Device, called an optical maser, developed for amplifying light that promises to be useful in space and other communication, television, astronomical photography and medical diagnosis.

9. The inauguration of a radio telescope watch for signals from outer space from intelligent beings on planets in other stellar systems.

10. A synthetic steroid pill contraceptive placed on sale by prescription.

Rocket Fuel at Half Price

➤ THE LIQUID rocket fuel, hydrazine, can now be produced for less than half the present price.

Aerojet-General Corporation, Azusa, Calif., reported at the American Rocket Society meeting that a nuclear reactor can produce hydrazine from ammonia at about 25¢ per pound. The process is being developed for the U. S. Air Force Air Material Command.

Uranium-235, suspended in ammonia, is used for the hydrazine production reactor. Fission fragments of uranium break up ammonia molecules, some of which recombine to form stable hydrazine.

Circulation is continuous with the stream becoming subcritical as it leaves the reactor. A yield of one molecule of hydrazine per 100 electron volts will produce an economical plant.

Experiments have exceeded this yield. Ammonia, hydrazine and uranium are drawn out of the reactor stream. A cyclone separator removes the uranium-235 and feeds it back into the reactor. Hydrazine and ammonia are drawn off for additional processing, and then separated.

Fission fragments are removed and the ammonia is fed back into the reactor.

Scientists in Campaign

by Lillian Levy

➤ Never have scientists been so politically prominent and dominant as in the Presidential campaign just concluded. But their political actions were not motivated entirely by scientific interests.

Considerations of defense, the problem of arms control, international prestige, the desire to participate in public affairs as an integrated member of the community, and personal friendship were some of the reasons behind the wholesale exodus of this professional group from their traditional ivy-tower isolation. And a large number of the country's leading scientists lent their support to President-elect John F. Kennedy.

Dr. Kusch

Dr. Polykarp Kusch, 1955 Nobel Prize winner in physics and a professor at Columbia University, told Science Service that his political participation was motivated by partisan considerations. However he functioned in the Democratic party "primarily as a scientist."

"During the past year," he said, "I have been a member of the Democratic Advisory Committee on Science and Technology, working on national goals for scientific research and achievement together with other members of the Committee."

Dr. Kusch said it was "inconceivable" that a first-rate scientist, Republican in his convictions, would be setting such goals under a Democratic party label.

"Suppose a man of religion wanted to make an impact on the religious life of the nation. Wouldn't he choose to make that impact through the religion of his personal conviction rather than another," the physicist said by way of illustration, adding that logically the same would hold true for a man of science.

Dr. Wiesner

Dr. Jerome B. Wiesner, a member of President Eisenhower's Science Advisory Committee, is a long-time personal friend of the President-elect. A physicist, Dr. Wiesner is an expert on radiation research at Massachusetts Institute of Technology.

It is no secret that the President-elect has long considered Dr. Wiesner his "top adviser" on nuclear aspects of defense and arms control. These are areas in which the physicst also has worked with President Eisenhower, for whom Dr. Wiesner has the "highest regard and deepest respect."

However, Dr. Wiesner said in an interview, he is convinced that the solution of these major problems of defense and arms control may be achieved more swiftly under Democratic leadership.

Dr. Bethe

Dr. Hans Bethe of Cornell, another former member of President Eisenhower's Science Advisory Committee who actively supported the election of Senator Kennedy, takes the position that the questions of arms, defense and nuclear control are "issues that go across party lines."

XUM

"I find President Eisenhower closer to Senator Kennedy on these matters than are some Democrats," he said.

Dr. Bethe sides with the Democrats because "on the whole" he believes that such goals as a workable agreement for nuclear test ban and the peaceful development of atomic power are shared by more Democrats. He is in favor of nuclear testing only to improve detection capability and is strongly opposed to further testing for the improvement of weapons.

Dr. Kantrowitz

Dr. Arthur Kantrowitz of AVCO Research Corporation, Everett, Mass., and a consultant to the Administration on space technology, believes that the more competitive spirit "as evidenced in this campaign by the Democrats under Senator Kennedy is what we need to advance us across the board in all areas — industry, health, education, as well as science — so that we may gain back international prestige lost to the Russians."

Dr. Urey

Dr. Harold C. Urey, physicist at Scripps Institution of Oceanography, La Jolla, Calif., and Nobel Prize Winner, who also has worked on the Democratic Science Advisory Committee, said his efforts in science certainly are not colored by partisan considerations. Atom and space research are of special interest to him, but as a politically active citizen he is interested in much broader problems than these areas of science, such as greater industrial development, education in general "not just for science," and looks to advances under the Democrats in these broad areas.

"I hold myself ready to help President-elect Kennedy, whom I admire very much," Dr. Urey said.

Dr. Kaplan

Dr. Joseph Kaplan, head of the physics department at the University of California at Los Angeles, has been among the scientists most consulted by Vice-President Nixon.

The geophysicist said, "The Vice-President was in contact with me all through the IGY. I know he is aware that I am a registered Democrat."

Dr. Kaplan stressed the fact that his scientific advice to the Vice-President was limited to areas of science in his special competence.

The Vice-President may not have received Dr. Kaplan's vote for the Presidency, but he gets the scientist's wholehearted endorsement as an intelligent listener "unusually responsive to people and information."

"If he ever took elementary physics from me, I would expect him to make an A in the course," the University of California physicist said.

The high hopes and expectations of these and other leading scientists for national advances under his leadership present the country's youngest President-elect with a challenge he is eager to meet.

FREE — Miniature chemical elements chart listing 102 elements in English, French, German, Russian; physical constants, discovery, occurrence, preparation, uses.

— Send stamped, self-addressed envelope to 315, South Lancaster, Mass. —

Book Condensations

HANDBOOK OF FILTRATION — *Eaton-Dikeman Co.,* 124 p., illus., $2.50. Data on paper filtration for chemistry student, laboratory technician and process engineer.

MODERN HIGH SCHOOL CHEMISTRY: A Recommended Course of Study — Edward F. Pierce — *Teachers College,* 109 p., paper; $1.50. To meet the needs of classes in senior high schools of the comprehensive type.

CATALYSIS, Vol. VII: Oxidation, Hydration, Dehydration and Cracking Catalysts — Paul H. Emmett, Ed. — *Reinhold,* 378 p., $13.50. Reference source on physical chemistry of catalysis and catalytic processing. Final volume of series.

SMITH'S COLLEGE CHEMISTRY — William F. Ehret — *Appleton,* 7th ed., 960 p., illus., $7.75. Authoritative treatment of fundamental principles of chemistry, reorganized and largely rewritten.

ELEMENTS OF GENERAL CHEMISTRY — Jay A. Young — *Prentice-Hall,* 466 p., illus., $6.95. Aims at giving the student understanding of the properties of typical elements and compounds.

THE DETERMINATION OF MOLECULAR STRUCTURE — P. J. Wheatley — *Oxford Univ. Press,* 263 p., illus., $5.60. Introduction to spectroscopic methods, electron and X-ray diffraction, dipole moments and nuclear magnetic resonance.

POLYESTER RESINS — John R. Lawrence — *Reinhold,* 251 p., illus., $5.75. Chemistry and applications of unsaturated polyester resins, widely employed in reinforced plastics.

MAGNESIUM AND ITS ALLOYS — C. Sheldon Roberts — *Wiley,* 230 p., illus., $9. Reference work of value to chemists, physicists, metallurgists and engineers.

ATOMS, MOLECULES, AND CHEMICAL CHANGE — Ernest Grunwald and Russell K. Johnsen — *Prentice-Hall,* 252 p., illus., $6. Introductory text for non-science majors, emphasizes structure of matter and the chemical consequences of that structure.

X-RAY SPECTROCHEMICAL ANALYSIS — L. S. Birks — *Interscience,* 137 p., illus., $5.75. Up-to-date material on excitation, dispersion, detection, quantitative analysis of techniques, and the electron probe microanalyzer.

AMERICAN INDUSTRY IN EUROPE — Hugo Uyterhoeven with Richard F. Messing and Duane M. Feeley — *Arthur D. Little,* 98 p., color graphs, $3. Report on the Arden House Conference on the European Common Market and the American chemical industry.

PETROLEUM SOURCEBOOK 1959: A Regional Bibliography of Petroleum Information — Curtis Stevens, Ed. — *Nat. Petroleum Bibliography,* 234 p., paper, $7.50. Worldwide directory of information sources classified by country, region and state.

Chemistry Comments

Interesting facts in the chemical world.

➤ Calcium is needed at every age for upkeep of bones and normal functioning of nerves and muscles, including the action of the heart.

➤ Coating the edges of a drawer and runway with paraffin, wax or powdered graphite may prevent sticking.

➤ To remove rough and sticky spots from an iron, run it hot over a piece of paper or cloth sprinkled with salt.

➤ Steel wire woven into cloth much finer than the finest weave for ladies' hosiery is used for industrial filters.

➤ Onion odors and fruit stains can be removed from hands by rubbing them with a piece of lemon dipped in salt.

➤ A solution of salt and turpentine can often remove yellow stains from a lavatory or bathtub.

➤ Steel surface coverings for high-speed military aircraft are being made six thousandths of an inch thick, about twice the diameter of a human hair.

➤ The U. S. currently uses about 75% of its fuels in fluid form, and about 10% of this amount is imported.

➤ Evaporation of water on the sea surface and the eventual precipitation of the vapor follow a complete cycle that sustains life on the earth.

➤ Residents of the U. S. are expected to use over four times as much coal and oil for energy in the year 2000 as they used in 1958.

➤ World coal and oil consumption in the year 2000 will be over five times the consumption in 1958.

➤ Modern-day plastic balloons, made of material thinner than a human hair, have reached 126,000 feet — above 99.6% of the earth's atmosphere.

➤ A collection of meteorites from nearly half the 1,600 falls known to science, representing the fourth largest collection of its kind in the world, has been acquired by the University of Arizona.

➤ The electron, the particle upon which the industry of electronics is based, weighs only 1/1846 as much as a hydrogen atom, the lightest atom known to science.

➤ The Great Lakes are the world's largest source of drinking water.

➤ Peaches are good sources of Vitamin A, contain small amounts of vitamins B and C and various minerals.

➤ The fuel consumed by an intercontinental ballistic missile in one minute could run an automobile for the next thirty years.

➤ The first plastic sanitary sewer main in the U. S. was installed recently in Needham, Mass., where they are also using plastic for storm sewers.

➤ Rush and wicker chair seats can be improved by coats of shellac sprayed from an aerosol can.

New Revised Edition

THE CHEMICAL ELEMENTS

by Helen Miles Davis

Revisions by Dr. Glenn T. Seaborg, Nobel Prize Winner

THE THRILLING STORY OF MAN'S DISCOVERY OF THE BUILDING BLOCKS OF THE PHYSICAL UNIVERSE . . .

Completely up-to-date, fully indexed, invaluable for reference. An essential, highly readable handbook for every student, teacher, professional chemist! This handbook may be purchased with funds under Title 3 of the National Defense Education Act.

This is the authoritative story of their discovery and all that is known of their construction, so simply told that anyone may understand it.

The fascinating array of the building blocks of matter is fully covered from H for hydrogen to those elements discovered in the atomic era, numbered 93 to 102. And the story of each element, its properties, sources of the most important varieties (isotopes), characteristic compounds, and place in periodic tables appears here in a clear and readily understandable form.

SCIENCE SERVICE — 1719 N St., N.W. — Washington 6, D. C.
Send me _____ copies of "The Chemical Elements" at the rate of 10 or more at 50 cents each, less than 10 copies 55 cents each, postpaid.

( ) $_____ enclosed ( ) Bill me

Name _____

Address _____

City, Zone, State _____

1-61

33 M